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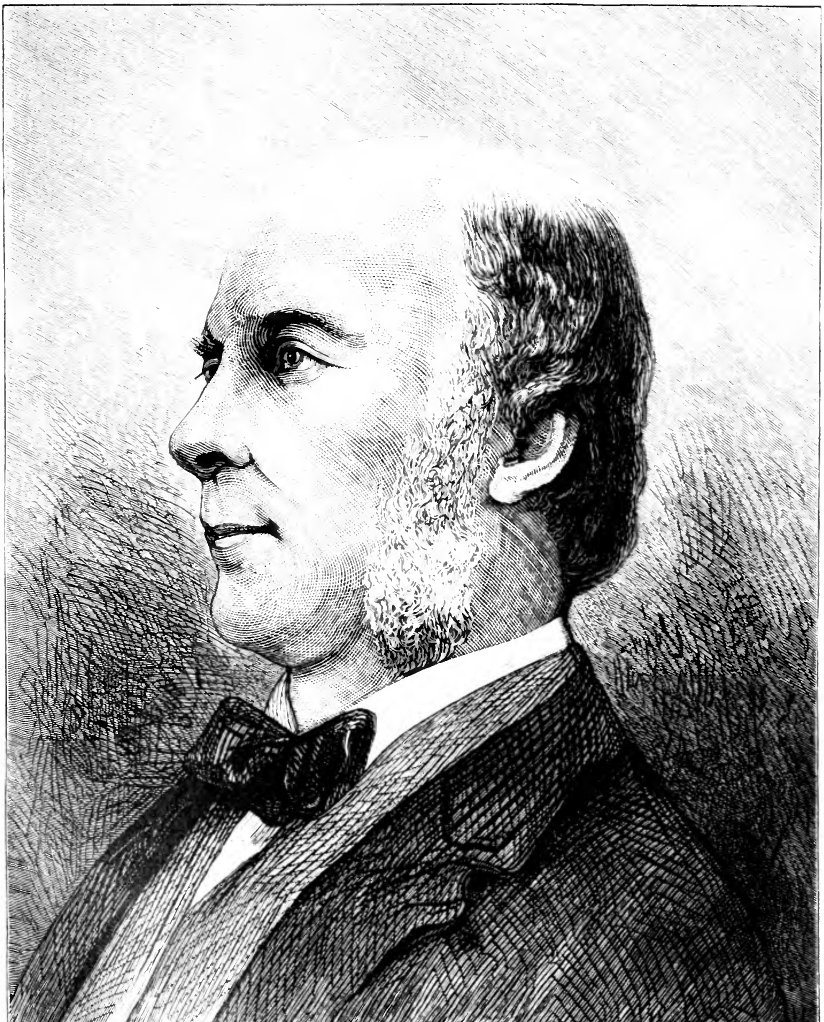

FRANCIS GALTON.

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THE DIFFICULTIES OF RAILROAD REGULATION.

By ARTHUR T. HADLEY.

ANY practical scheme of railroad control is likely to be based upon a compromise. The different interests involved are so conflicting that it will not do to attempt a solution from any one standpoint exclusively. The direction which legislation is to take can not be decided by a mere consideration of complaints against the existing system, whether well-grounded or otherwise. We must also consider what other systems have been tried, and what evils they have involved; what lines of treatment have been undertaken, and how far it has been found possible to carry them out. It is not a question what we would like to do, so much as what we actually can do.

The community requires four things of its railroad system:

1. That it shall afford sufficient facilities to meet the wants of business. In other words, there must be enterprise in building new lines, and in keeping the old ones up to a high standard of efficiency.

2. That the charges, as a whole, shall be as reasonable as possible. If they are higher than those of other countries, or higher than is necessary for the support of the railroads, the business development of the community will be retarded.

3. That there shall not be arbitrary differences in charge which force business into unnatural and wasteful channels, or cripple one man for the enrichment of another.

4. That there shall be as little waste of capital as possible, either by corruption, extravagance, or want of business skill. This is not quite so vital a matter as the other three, but it is one which we can not afford to leave out of account.

No system of regulation is ever likely to be devised which shall secure all these results. Free competition, as we have tried it in

America, produces rapid construction and low rates, but fosters discrimination and extravagance; thus securing the first and second requirements, at the sacrifice of the third and fourth. The French system of regulated monopoly has just the opposite effect; it prevents waste and discrimination, but development is slow and rates are high. The third and fourth requirements are secured at the expense of the first and second. England enjoys the first and fourth advantages, at the sacrifice of the second and third; Italy has secured the second and third, but failed of the first and fourth. The Granger system of regulation sacrificed the first in the effort to secure the second. Partial state ownership, as we shall see, secures nothing at all; exclusive state ownership secures the third, at great risk of sacrificing all the others.

The different requirements are to a certain extent in conflict with one another. This conflict can only be understood by studying the history of railroads, and the principles which underlie railroad business management. These are quite imperfectly known at present. There is probably no subject of equal importance on which public enlightenment is so much needed. The capital invested in the railroads of our country is eight times that of its banking institutions; the tonnage carried by rail is four times that carried by water; the abuses in internal commerce come home to most of us far more directly than those in foreign commerce. Yet, for every man who has studied the political economy of railroads, there are a dozen who have studied that of shipping and foreign trade, and a hundred who have studied that of banking. The complications of the subject are hardly recognized. Railroad reformers are far too ready to blindly pursue one specific object or combat one specific abuse, regardless what other objects may be sacrificed, or what other abuses fostered by their policy.

From 1830 to 1873 the main object of nearly every community was to secure rapid development of railroad facilities—the first of the four requirements we have named. The railroad proved so much superior to other modes of transportation, that the country which had railroads prospered; that which had not railroads fell behind. Legislation was everywhere devised to favor this end. Where capital was ready to invest, every encouragement was offered it. If the removal of obstacles was not enough, a subsidy was generally to be had for the asking. If the community could not afford to pay a subsidy outright, it guaranteed a certain income to the road. If all these inducements were insufficient, the state stepped in and built the road itself. In England, where there was plenty of capital seeking investment, railroads were chartered literally by hundreds. In America they were not only exempted from the necessity of securing special charters, but received municipal aid, as well as grants of public land on a scale which was often outrageous. In France the state paid half the cost of building the road, and offered the companies monopoly privileges as an induce-

ment for supplying the other half. Belgium built the main lines of road at state expense for state management; but at the same time the building of private lines was also encouraged in every possible way. It was not until too late that men saw what chances for waste and corruption were involved in this indiscriminate encouragement of railroad construction. England learned the lesson in 1847; Continental Europe in 1873. In spite of the severe experiences of 1857, 1873, and 1884, it is by no means certain that America has learned it even yet.

For a long time the only fear was that railroad charges would be too high; and this fear was happily disappointed. The maximum rates which were fixed in the earliest charters were useless, simply because the railroads generally adopted a lower scale of their own accord. It was found that the profits depended quite as much upon the volume of business as upon the absolute rates charged, and that it was often better to do a large business at low rates than a smaller business at higher rates. This is of course true to some extent in every department of industry, but there are reasons which make it apply specially to railroads. About half* the expenses of a railroad are to a considerable extent independent of the amount of work done. Thus an increase in the volume of traffic does not produce a corresponding increase in cost.

Railroad expenses may be roughly divided into two classes, according as they do or do not vary with the amount of business done. Those which do not vary rapidly are called fixed charges. This includes interest on cost of construction, the general expenses of the organization as a whole, and a considerable part of the expense of maintenance, which is due to weather rather than to wear. Those expenses which vary nearly in proportion to the amount of business done are called operating expenses. Under this head are included the different items of train and station service, with some others. The fixed charges of the railroads of the United States average somewhat over $2,500 per mile annually; the operating expenses average from forty to sixty cents per train-mile.

In order that a railroad as a whole may be profitable, it is necessary that it should earn money enough to pay fixed charges as well as operating expenses. But, in order to secure any individual piece of business, it can afford to make rates which shall little more than cover operating expenses, provided such business can be had on no other terms. To secure traffic which it could not otherwise have, a railroad can afford to make rates which would bankrupt it if applied to its whole business.

* In Mr. Lansing's valuable article on this subject ("Popular Science Monthly," February, 1886), the proportion is estimated considerably higher. Any argument on the reasons for the difference would be of too technical a character to come within the scope of this discussion.

Such was the origin of discriminations. Sure of a certain amount of traffic at high rates, which would contribute its full share to the payment of fixed charges, each railroad strove to secure additional traffic at lower rates which would little more than pay operating expenses. This reduction was first made in favor of articles of low value, like coal, stone, or lumber, which could not be moved at all at high rates, but which could furnish a large business at low rates. Here it was an unmixed benefit to the public. The reduction was next applied in favor of long-distance traffic ; and here also it was a good thing in principle, though sometimes overdone in practice. Under the old system of equal mileage rates, where the charge was made proportional to the distance, it would have cost something like a dollar a bushel to get wheat from the Mississippi Valley to the seaboard ; a price which would have been simply prohibitory to the growth of the Western States.

There were special circumstances which led the railroads to give the long-distance traffic more than its due share of favor. A great deal of this traffic had the benefit of competition, either between several lines of railroad, or between rail and water routes. The reductions in rates were made most rapidly where such competition was most active—that is, at the large cities. The result was a system which favored cities at the expense of the country—by no means a good thing. But this was not the worst. In any period of active railroad competition large shippers were almost always given lower rates than small shippers. Amid the constant variation of rates, unscrupulous men gained advantages at the expense of more honorable men. Secret favors were generally given to those who least needed or least deserved them. The railroad agents forgot their obligations to the public as common carriers. Too often they were ready to sacrifice even the permanent interests of the stockholders themselves in the lawless struggle for competitive business.

It must not be forgotten that railroad competition did some things for the country which nothing else could possibly have done. It taught our railroad men to handle a large business cheaply. It taught them to make money at rates which would have seemed suicidal to the easy-going managers who were not under any such stimulus. The rapid reductions of charge, in other countries as well as America, have been made in the stress of railroad wars. But, while railroad competition has been in some respects a beneficent force, it can not be trusted to act unchecked. To the business community regularity and publicity of rates are more important than mere average cheapness. Business can adjust itself to high rates easier than to fluctuating ones. And railroad competition of necessity makes rates fluctuate. It tends to bring them down to the level of operating expenses, regardless of fixed charges. If it acts everywhere, as in the case of the New York Central and West Shore, it leaves little or nothing to pay fixed charges,

and means ruin to the investor, followed by consolidation. If it acts at some points and not at others, those points which have the benefit of competition have rates based on operating expenses, while the less fortunate points pay the fixed charges. Then we have discrimination in a dangerous form.

As long as competition exists, there is no escape from this alternative. If it exists at all points, it means ruin; if it exists at some points, it means discrimination. The efforts to prevent these results by law while retaining the principle of competition, only show how powerless we really are in this matter. Let us look at them in order.

The first legislators tried to treat the railroad as a public highway, over which any man should be at liberty to run cars, as he can run boats over a canal or wagons over a turnpike. This idea was incorporated in the railroad charters of England and Prussia. It has never been quite abandoned by theorists; but practically it has proved a failure wherever tried. Physically it is impossible, on account of the danger of collision; industrially it is impossible, on account of the added expense. Nobody would build a railroad on such terms unless the mere tolls for the use of the track were to be made higher than the whole transportation charge now is.

A second plan for making competition a public benefit has been that of state ownership of part of the competing lines. It has been tried on a large scale in Belgium and Prussia, and on a smaller scale in most other countries, the United States not excepted. It was thought by the advocates of the system that the government would thus obtain a controlling influence over the railroads with which it came in contact, and be able to regulate their policy by its example. These hopes have been disappointed. The private railroads under such circumstances regulate those of the government far more than the government regulates the private railroads. There is no chance to carry out any schemes of far-sighted policy. If the private roads are run to make money, the government roads must be managed with the same end in view. The tax-payers will not let the government lines show a deficit while competing private lines pay dividends. No administration would dare to allow such a thing, however important the end to be attained. As a matter of fact the government roads of Belgium and Germany were as ready to give rebates as the private lines with which they came into competition. In Belgium they went so far as to grant special rates to those persons who would agree not to ship by canal under any circumstances. The same thing has been done in New York State; but in Belgium the peculiar thing was that the canals and railroads both belonged to the government, and yet were fighting one another in this way. The system of partial state ownership was hardly distinguishable in its effects from simple private ownership. This fact has been clearly recognized within the last twelve years. Within this period, Belgium, Prussia, and Italy have abandoned the "mixed sys-

tem." Belgium and Prussia have made state management all but universal; Italy has practically given it up.

Of much more importance in the United States has been the effort to regulate charges by legislation, without touching the question of ownership. There was no lack of authority for so doing. Common carriers had been made the subject of special regulation from time immemorial, and it was a well-accepted principle that their charges must be reasonable.

But what constitutes a reasonable charge? On what basis are we to compute it?

It is by no means a sufficient answer to say that rates should be based upon cost of service. What items of cost shall we include? Shall we count the fixed charges, or simply consider operating expenses? In the earliest legislation the former course was adopted. The English tolls and *maxima* were calculated upon this basis. But they were soon found to be so high as to be almost inoperative. At any rate, they did not prevent discrimination. They allowed the railroad to earn its fixed charges where it chose, and to lower rates elsewhere. A prescribed rate of this kind is too high to be of any use.

On the other hand, to prescribe a rate which does not provide for fixed charges is even worse. This was tried in the Mississippi Valley in the Granger movement. It was argued by the farmers that, if the railroads could afford to carry their competitive traffic at very low rates, they could afford to do the same for the local traffic. All rates were therefore reduced by law to the basis of the competitive ones. What was the result? In Wisconsin, where the system was carried out most completely, a law of this kind was in operation for two years. At the end of that time, not a single railroad was paying dividends; only four were paying interest on their bonds. Railroad construction was at a stand-still. The existing roads could not afford to extend their facilities for traffic. The development of the State was checked—checked so abruptly that the very men who were most clamorous for the railroad law in 1874 were most clamorous for its repeal in 1876. In their anxiety to secure low rates, they had overlooked the necessity for railroad development. This oversight reacted forcibly against them; and the same reaction is likely to be felt wherever reckless railroad legislation is attempted. Our railroad profits are not so high as is often supposed. They are less than four per cent on the nominal capital; and, making all due allowance for water, probably less than six per cent on the actual investment. Admit, if you please, that the corruption of inside rings absorbs an additional amount which *ought* to go to the investor; this does not affect the fact that, if your legislation prevents the investor from receiving his dividends, he will not invest his capital in your State. It is not now a question of ethics as to what you or he ought to do; it is a matter of fact, proved by actual experience as to what he will do.

Fortunately, no other State had quite so severe an experience as Wisconsin. There were somewhat similar laws in other States, for instance, in Illinois; but the enforcement of the Illinois law was intrusted to a commission. The commissioners were not men of experience in these matters, but they had the sense to see that the attempt to reduce rates too sharply would defeat the purposes in view. They therefore used their powers with some discretion; not attempting to reduce rates everywhere at once, but simply to correct the worst abuses. They were not altogether successful, but they made no such disastrous failure as occurred in Wisconsin.

There is an undeniable advantage in entrusting the execution of such a law to the somewhat discretionary power of a commission. A court is not well qualified to enforce a hard and fast law concerning railroad rates. The courts are compelled to rely somewhat blindly upon precedent; while railroad management is so new a thing that the precedents derived from other lines of business are often misleading. The best proof of the usefulness of railroad commissions is the extent to which they have prevailed. Nearly two thirds of our States have them; there is scarcely a serious attempt at railroad regulation in the United States except through some such agency.

But, even in the best hands, the power to fix rates is of somewhat doubtful utility. More effective statutes have been aimed at discrimination itself—not to fix the rate, but to limit the chance for arbitrary differences. In one sense it ought hardly to need a statute to do this. Secret rebates and personal discriminations are so clearly against the spirit of the law of common carriers, that to call public attention authoritatively to these things is to condemn them. The work of the Hepburn Committee in New York, in 1879, had a value of this kind, quite apart from any positive legislation which it secured. The value of similar work done by certain railroad commissions can hardly be overestimated.

The worst abuses may be thus checked; but, as long as competition is at all active, there will be a good deal of local discrimination in favor of competitive points, which the common law is powerless to prevent. Against this system the so-called "short-haul" laws have been aimed. Probably no other point with regard to railroad regulation has been made the subject of so much discussion.

The short-haul principle provides that a railroad shall not charge a larger gross sum for a part of any route than it does for the whole—not more, for instance, from Chicago to Springfield, Massachusetts, than from Chicago to Boston. It is thus intended to prevent the more outrageous forms of local discrimination. There can be no doubt that as a general principle it is correct. But it is not one which it is always possible to enforce by law. If the law can reach all the rival routes, and can be enforced against all of them, it does much good and little or no harm. But, if it reaches one route and not another, it sim-

ply makes the other route a present of the through traffic. What, for instance, would be the effect of a national short-haul law on the movement of wheat from Chicago to the seaboard? At present, it is a traffic which the railroads can afford to make special efforts to secure, and they bring the rates down nearly to the level of operating expenses. If they reduced local rates to this basis, they would have nothing left to pay fixed charges. The only way by which they could comply with the law would be by raising through rates. This would simply have the effect of sending the wheat to Europe *via* Montreal instead of *via* American ports. The Grand Trunk Railroad, which would be outside of our control, would have the chance to make low through rates, and get the heavy through traffic. The English stockholders of the Grand Trunk would be the persons most benefited by such a law.

It is only a few years since the Prussian Government got into trouble in exactly this way. It was thought by the authorities that the low through rates favored the foreigners at the expense of the Germans; and an attempt was made to carry out the short-haul principle rigidly. The result simply was that the foreigners sent their goods by other routes which Bismarck was unable to control, and that the Prussian railroads lost a part of their traffic, which, low as were the rates charged upon it, was yet a matter of importance to their business prosperity.

Similar instances could be cited from almost any other country. Whenever we find a competitor which our law can not reach—be it water-route, foreign railroad, or domestic railroad which violates the law in an underhand fashion—the short-haul principle simply cripples the roads which obey it, without producing any corresponding good effect.

Experience has shown pretty clearly that local discrimination can be avoided only by bringing competition under control. The States where legal regulation of this matter has been most successful have been those like Georgia and Iowa, where the pooling system has been strongest and most stable, or those like Massachusetts, where competition has become, in local business, largely a thing of the past. Everywhere, in America and in Europe, periods of active competition have been periods of active discrimination. To check the second you must control the first. And the only practicable way of doing this, short of actual consolidation, is by a system of pooling. The mere agreement to maintain rates is not enough,; it is too easily violated by secret rebates. An agreement to divide the traffic or the earnings, as long as it holds at all, is much harder to violate secretly. This is what constitutes a "pool."

We are thus reduced to the simple alternative, pooling or discrimination. Each effort to prohibit both at the same time only makes the necessity more clear. The governments of Continental Europe have ceased to struggle against it. Rightly judging that discrimination is

the main evil, they recognize pools as the most effective method of combating it. State roads enter into pooling contracts with private roads, railroads divide traffic with competing water-routes. The law, recognizing such contracts, is able to regulate them, and to deal with organizations of railroads better than it could deal with railroads individually.

In this respect they have the advantage over us in America. In our vain effort to prohibit pools altogether, we have simply intensified their worst features. By refusing to recognize them at all, we have rejected the chance to regulate them. We have done worse than this. By taking all permanent guarantees away from them, we have forced them to pursue a short-sighted policy. The prejudice against pools, as we have often seen them, is not an unreasonable one; but the fault is in the law quite as much as in the system. Admit, if you please (though it is by no means clear), that the disastrous multiplication of roads in 1882 was mainly due to the short-sighted manipulation of rates under the pooling systems: what then? Such short-sighted policy was an almost necessary result of a legal theory which refused to enforce pooling contracts, and made their continuance depend upon the voluntary adhesion of all parties. The pool was compelled to adopt a policy which should keep every one in good-humor for the day. The moment the directors of a single road were dissatisfied with present results, they could break the system down, regardless either of the rights of others or of their own permanent welfare.

No policy can be more suicidal than this. The temporary interests of the railroads often diverge widely from those of the community which they serve. Their permanent interests are almost identical. The sound and strong roads, with a permanent character to sustain, are much more likely to be managed in the public interest than roads on the verge of bankruptcy, whose only thought is for the present. Yet all our legislation is directed against roads of the former class. We place them at the mercy of reckless competition in the matter of rates. We allow the building of insolvent competitors by construction companies whose operations are no better than blackmail. We strive to limit their dividends, when the only practical results of such a measure will be diminution of enterprise and increase of extravagance. In our fear that the influence of railroad managers may become too great, we have devised laws which seriously interfere with their power for good, and leave their power for evil almost unchecked.

To this sweeping statement one important exception must be made. More by accident than by design, the railroad commissioners in a number of our States have become the representatives of the permanent interests of the railroads and community alike, against the short-sighted policy of extremists on either side. The history of the Massachusetts Commission has presented the most marked instance of what can be done in this way, by a body of men having no power except the

power to secure publicity; it is perhaps the most encouraging example in recent history of the power of government by public opinion.

Whether a national commission could work successfully in this way is very doubtful. The public opinion of the nation as a whole is not so easily brought to bear in any one direction as is that of a single State. The national railroad system is too vast, the interests of different sections too conflicting. It is desirable that a national commission should be charged with the enforcement of certain specific provisions against discrimination. It would be a herculean task; but it is one which needs to be done, and one which we may feel reasonably sure that the courts could not even attempt to do.

On the other hand, it is desirable that the commission should not be a mere prosecuting body, but should depend for its force upon the influence of public opinion behind it. In this respect, the bill now before the United States Senate is a good one. It avoids alike the error of those who would give the commission no definite authority, and those who would charge it with doing what is actually impossible. The bill, as reported, rigidly prohibits personal discrimination, and generally prohibits local discrimination; but under this latter head it empowers the commission to make exceptions. It says nothing about pools; and, if this discreet silence is maintained, such a commission might readily use pools as a means of protecting the shipper against discrimination, instead of allowing them to be used solely for the purposes of the railroad investors and managers.

The great danger is, that the bill is too moderate to pass. In spite of all that has been said and written on railroad questions, the great majority of men are extremists on this subject. Some want an absolute let-alone policy; some want an energetic attempt at control which would really defeat its own ends. Both of these classes are opposed to a bill of this kind. The advocates of the let-alone policy are afraid that it would be enforced. The advocates of vigorous control are afraid that it would stand in the way of more decisive action. They feel—and not altogether without reason—that the prolonged absence of national control may ultimately bring the question of government ownership in the foreground.

It must be remembered that a very considerable portion of the community believes in government railroad ownership, at least as an ideal. They perhaps exaggerate the evils of the present system, and certainly have the most unreasonable expectations of the good to be obtained from a change. It has been seriously argued with much show of figures, in a reputable working-men's paper, that it is possible to carry passengers from New York to San Francisco at a dollar apiece and make money on it, and that everything above this represents sheer extortion, which would be avoided by government ownership! Now, as long as these things are believed, their absurdity makes them none the less dangerous. In forecasting the future, we must reckon with

the number of votes, and not simply with the value of the argument by which those votes have been influenced. Each year's failure to adopt any measure of national control probably increases the number of votes which would be cast in favor of government ownership.

It can not be denied that government ownership furnishes the best theoretical solution of the railroad problem, if we could only assume that the Government were possessed of infinite wisdom and virtue. But practically this condition is far from being realized in the United States. The question is a practical rather than a theoretical one. In countries like Germany, where the civil service represents the best elements of the nation, state railroads have been a success, simply because of that fact. Whatever system will give you the best administrative talent is likely to prove most successful. But it would be a bold thing to say that the best administrative talent of the United States found its way into the civil service, or was likely to do so for the present.

A state railroad system may be relied upon to do one thing—to check local discrimination. But this is not due so much to any considerations of public policy as to the complete monopoly which takes away all inducements to discriminate. Where a state road comes into conflict with private roads, it makes discriminations of the worst form. Where it has a monopoly, there is danger that it will avoid them by leveling up. The Italian investigating commission of 1878, after a careful comparison of the actual experience of different countries, came to the conclusion that state railroads did not, as a rule, do so much for industry as private railroads; that in general their rates were higher, their facilities worse, their responsibility less; that the state railroad management was more apt to tax business than to foster it; while political considerations were brought into matters of railroad construction and management in a way which was disastrous alike to railroads and to politics. It may be that these conclusions were in some respects overdrawn; but they are sufficient to show the wide difference between the popular ideal of state railroad management and the reality as seen in actual practice.

AN ECONOMIC STUDY OF MEXICO.

By Hon. DAVID A. WELLS.

II.

THE Spanish rule over Mexico lasted for just three hundred years, or from 1521 to 1821; and, during the whole of this long period, the open and avowed policy of Spain was, to regard the country as an instrumentality for the promotion of her own interests and aggrandizement exclusively, and to utterly and contemptuously disregard the de-

sires and interests of the Mexican people. The government or viceroyalty established by Spain, in Mexico, for the practical application of this policy, accordingly seems to have always regarded the attainment of three things or results as the object for which it was mainly constituted, and to have allowed nothing of sentiment or of humanitarian consideration to stand for one moment in the way of their rigorous prosecution and realization. These were, first, to collect and pay into the royal treasury the largest possible amount of annual revenue ; second, to extend and magnify the authority and work of the established Church ; third, to protect home (i. e., Spanish) industries.

Starting with the assumption that the country, with all its people and resources, was the absolute property of the crown in virtue of conquest, the accomplishment of the *first* result was sought through the practical enslavement of the whole native population, and the appropriation of the largest amount of all production that was compatible with the continued existence of productive industries. With the civil power at the command of the Church, the attainment of the *second* result was from the outset most successful ; for, with a profession of belief and the acceptance of baptism, on the one hand, and the vigilance of the Inquisition and a menace of the fires of the *auto-da-fe* on the other, the number of those who wanted to exemplify in themselves the supremacy of conscience or the freedom of the will, was very soon reduced to a minimum. And, finally, the correctness or expediency of the principle of protection to home (Spanish) industry having been once accepted, it was practically carried out, with such a logical exactness and absence of all subterfuge, as to be worthy of admiration, and without parallel in all economic history. For, in the first instance, with a view of laying the axe directly at the root of the tree of commercial freedom, all foreign trade or commercial intercourse with any country other than Spain was prohibited under pain of death ; and that ordinance is believed to have been kept in force until within the present century. No schools or educational institutions save those of an ecclesiastical nature were allowed, and in these instruction in almost every branch of useful learning was prohibited. Certain portions of Mexico were admirably adapted, as they yet are, to the cultivation of the vine, the olive, the mulberry, and of fiber-yielding plants, and also for the keeping and breeding of sheep ; but, as a colonial supply of wine, oil, silk, hemp, and wool might interfere with the interests of home producers, the production of any or all of these articles was strictly prohibited ; neither was any manufacture whatever allowed which could by any possibility interfere with any similar industry of Old Spain. When Hidalgo, a patriotic Catholic priest, about the year 1810, with a desire to diversify the industries of his country and benefit his countrymen, introduced the silk-worm and promoted the planting of vineyards, the authorities destroyed the one and uprooted the other ; and through these acts first

instigated the rebellion that ultimately overthrew the government and expelled the Spaniards from Mexico. All official posts in the country, furthermore, were filled by Spaniards, and the colonial offices were regularly sold in Madrid to the highest bidder.

In the National Museum in the city of Mexico is a nearly or quite complete collection of the portraits of the fifty-six Spanish viceroys who successively governed the country. The series commences with a portrait of Cortes, which is said to be an original; and, according to Mr. Prescott (who prefixed an engraved copy of it to the third volume of his "Conquest of Mexico"), has been indorsed by one of the best Spanish authorities, Don Antonio Uguina, as the "best portrait" of the conqueror that was ever executed. It is an exceedingly striking face, full of character, and more quiet, contemplative, and intellectual than might have been expected from his stirring and eventful career; and as the picture is neglected and apparently in a state of decay, a copy of it ought at once to be acquired by our national Government and placed in the Capitol at Washington; or, in neglect thereof, by some one of our historical societies. For, whatever may be the opinion entertained concerning the man and his acts, there can be no question that he was one of the most conspicuous characters in American history, and has left his mark indelibly upon what is now no small part of the territory of the United States. Of the long series of portraits of his successors, as they hang upon the walls of the museum, the majority depicted in gorgeous vice-regal robes, and with stars and orders of nobility, there is this to be said—that, with few exceptions, they represent the most mediocre, unintellectual, and uninteresting group of faces that could well be imagined. They convey the idea that nearly all of the originals were men past the prime of life, whose business had been that of courtiers, and who had won their appointments either by court favoritism or from the supposed possession of qualities which would enable them to extort from the country and its people a larger revenue for the Spanish treasury than their predecessors. Among the few exceptions noted are the portraits of Don Juan de Acuña (1722–1734), the only Spanish viceroy born in America (Peru), and the Count de Revilla-Gigedo (1789–1794), both of whom were unquestionably rulers of great ability, and who might also well be represented in the national galleries of the United States; and the portraits of occasional ecclesiastical viceroys—bishops or archbishops—conspicuous among their neighbors by reason of their more somber vestments. The faces of these latter are not devoid of intellectuality, or indications of mental ability; but they are—one and all—stern, unimpassioned, and with an expression of grim malevolence and bigotry, which as much as says, "Woe betide any heretic, or contemner of Church supremacy, who dares to question my authority!" To which may be properly added that, during nearly all the long period of Spanish rule in Mexico, the Inquisition, or "Holy Office," wielded a power

as baleful and as despotic as it ever did in Old Spain, and held its last *auto-da-fe* and burned its last conspicuous victim—General José Morelos—in the Plaza of the city of Mexico, as late as November, 1815!

In 1810, Mexico, under the lead of Hidalgo—whom the modern Mexicans regard as a second Washington—revolted against its Spanish rulers, and, after many and varying vicissitudes, finally attained its complete independence, and proclaimed itself, in 1822, first an empire, and two years later, or in 1824, a republic. From this time until the defeat of Maximilian and his party in 1867, the history of Mexico is little other than a chronicle of successive revolutions, internecine strife, and foreign wars. In the National Palace, in the city of Mexico, is a very long, narrow room, termed the "Hall of Embassadors," from the circumstance that the President of the Republic here formally receives the representatives of foreign nationalities. Upon the walls of this room, and constituting, apart from several elaborate glass chandeliers, almost its only decoration, is a series of fairly painted, full-length portraits of individual Mexicans who, since the achievement of independence of Spain, had been so conspicuously connected with the state, or had rendered it such service, as to entitle them, in the opinion of posterity, to commemoration in this sort of national "Valhalla." To the visitor, entering upon an inspection of these interesting pictures, the accompanying guide, politely desirous of imparting all desirable information concerning them, talks somewhat after this manner:

"This is a portrait of the Emperor Iturbide, commander-in-chief of the army that defeated and expelled the last Spanish viceroy; elected emperor in 1822; resigned the crown in 1823; was proscribed, arrested, and shot in 1824. The next is a portrait of one of the most distinguished of the soldiers of Mexico, General Mariano Arista" (the general who commanded the Mexican troops at the battles of Palo Alto and Resaca de la Palma), "elected President of the Republic in 1851, was deposed and banished in 1853, and died in exile in 1855. His remains were brought home at the public expense, and a special decree commemorative of his services was declared by Congress. The next is General So-and-so, who also, after rendering most distinguished services, was shot"; and so on, until it seems as if there was not one of their conspicuous men whom the Mexicans of to-day unite in honoring for his patriotism and good service, but who experienced a full measure of the ingratitude of his country in the form of exile or public execution. In the same gallery is also a good full-length portrait of Washington, but, very appropriately, it is far removed from all the other pictures, and occupies a place by itself at the extreme end of the apartment.*

* Since the establishment of her independenee in 1821, Mexico, down to the year 1884—a period of sixty-three years—has had fifty-five presidents, two emperors, and one regency, and, with some three or four exceptions, there was a violent change of the gov-

In 1846 came the American war and invasion, when the United States, with "one fell swoop," as it were, took from Mexico considerably more than one half of all its territory—923,835 square miles out of a former total of 1,690,317. It is true that payment was tendered and accepted for about one thirty-fourth part (the Gadsden purchase) of what was taken, but appropriation and acceptance of payment were alike compulsory. For this war the judgment of all impartial history will undoubtedly be that there was no justification or good reason on the part of the United States. It may be that what happened was an inevitable outcome of the law of the survival of the fittest, as exemplified among nations; and that the contrasts as seen to-day between the life, energy, and fierce development of much of that part of Old Mexico that became American—California, Texas, and Colorado—and the stagnant, poverty-stricken condition of the contiguous territory—Chihuahua, Sonora, Coahuila—that remained Mexican, are a proof of the truth of the proverb that "the tools rightfully belong to those who can use them." But, nevertheless, when one stands beside the monument erected at the foot of Chapultepec, to the memory of the young cadets of the Mexican Military School—mere boys—who, in opposing the assault of the American columns, were faithful unto death to their flag and their country, and notes the sternly simple inscription, "Who fell in the North American invasion"; and when we also recall the comparative advantages of the contending forces—the Americans audacious, inspirited with continuous successes, equipped with an abundance of the most improved material of war, commanded by most skilled officers, and backed with an overflowing treasury; the Mexicans poorly clothed, poorly fed, poorly armed, unpaid, and generally led by uneducated and often incompetent commanders; and remember the real valor with which, under such circumstances, the latter, who had received so little from their country, resisted the invasion and conquest of that country; and that in no battles of modern times have the losses been as great comparatively as were sustained by the Mexican forces—there is certainly not much of pleasure or satisfaction that a sober-minded, justice-loving citizen of the United States can or ought to find in this part of his country's history. And, if we are the great, magnanimous, and Christian nation that we claim to be, no time ought to be lost in proving to history and the world our right to the claim, by providing, by act of Congress, that all those cannon which

ernment with every new administration. The year 1848 is noted in Mexican annals as the first time when the presidency was transferred without violence and under the law—General Arista peaceably succeeding General Herrera. But Arista was deposed and banished in the next two years, and in the next three months there were four presidents of the republic. Of the original and great leaders in the war of independence—namely, Hidalgo, Morelos, and Matamoros—all were shot. The same fate befell both of the emperors, and also two of the more noted presidents—Guerrero and Miramon. Of the other presidents, nearly all at one time or other were formally banished or compelled to flee from the state in order to escape death or imprisonment.

lie scattered over the plains at West Point, bearing the inscriptions "Vera Cruz," "Contreras," "Chapultepec," "Molino del Rey," and "City of Mexico," and some of which have older insignia, showing that they were originally captured by Mexican patriots from Spain in their struggles for liberty; together with every captured banner or other trophy preserved in our national museums and collections, be gathered up and respectfully returned to the Mexican people. For, to longer retain them and pride ourselves on their possession, is as unworthy and contemptible as it would be for a strong man to go into the street and whip the first small but plucky and pugnacious boy he encounters, and then, hanging up the valued treasures he has deprived him of in the hall of his residence, say complaisantly, as he views them, "See what a great and valiant man I am, and how I desire that my children should imitate my example!" If it is peace and amity and political influence, and extended trade and markets, and a maintenance of the Monroe doctrine on the American Continent that we are after, such an act would do more to win the hearts and dispel the fears and suspicions of the people of Mexico, and of all the states of Central and South America, than reams of diplomatic correspondence, and endless traveling trade commissioners and formal international resolutions. Society is said to be bound by laws that always bring vengeance upon it for wrong-doing—"the vengeance of the gods, whose mills grind slow, but grind exceeding small." What penalty is to be exacted of the great North American Republic for its harsh treatment and spoliation of poor, down-trodden, ignorant, superstitious, debt-ridden Mexico, time alone can reveal. Perhaps, as this great wrong was committed at the promptings or demand of the then dominant slave-power, the penalty has been already exacted and included in the general and bloody atonement which the country has made on account of slavery. Perhaps, under the impelling force of the so-called "manifest destiny," a further penalty is to come, in the form of an equal and integral incorporation of Mexico and her foreign people into the Federal Union. But, if this is to be so, the intelligent and patriotic citizens of both countries may and should earnestly pray that God, in his great mercy, may yet spare them.

In 1861, Louis Napoleon, taking advantage of the war of the rebellion in the United States, and regarding (in common with most of the statesmen of Europe) the disruption of the Great Republic as prospectively certain, made the suspension by Mexico of payment upon all her public obligations, a great part of which were held in Europe, a pretext for the formation of a tripartite alliance of France, England, and Spain, for interfering in the government of the country; and in December, 1861, under the auspices of such alliance, an Anglo-French-Spanish military force landed and took possession of Vera Cruz. From this alliance the English and Spanish forces early withdrew; but the French remained, and soon made no secret of their intent

to conquer the country. The national forces, under the leadership of undoubtedly the greatest and noblest character that Mexico has produced, Benito Juarez, reported to be of pure Indian parentage, offered a not inglorious resistance; and in at least one instance undoubtedly inflicted a severe defeat upon the French army. But with the almost universal defection of the clergy and the wealthier classes, and with the country weakened by more than forty years of civil strife and an impoverished exchequer, they were finally obliged to succumb; and after a period of military operations extending over about sixteen months, or in June, 1863, the French entered the city of Mexico in triumph and nominally took possession of the whole country. A month later, a so-called "assemblage of notables," appointed by the French general-in-chief, met at the capital, and with great unanimity declared the will of the Mexican people to be the establishment of an empire in the person of the Archduke Maximilian of Austria, "or such other prince as the Emperor Napoleon should designate"; and in pursuance of this act the crown was formally offered to Maximilian at his palace in Austria in October, 1863, and definitely accepted by him in April, 1864. Viewed in the light of subsequent events, the point of greatest interest and importance in this scheme on the part of Louis Napoleon for the conquest of Mexico and its conversion into a French dependency, to the humiliation of whatever political organizations might be left after the war to represent the former Federal Union, and to the utter discomfiture of the "Monroe doctrine"—a scheme which Napoleon designed should constitute the most brilliant feature of his reign—was the connection of the Church of Mexico and its adherents with the movement. If not, indeed, as is often suspected, the instigators of it in the first instance, they were undoubtedly in full sympathy with it from its inception—and with good reason. For as far back as 1857, Juarez, when a member of the Cabinet of General Comonfort, had been instrumental in the adoption of a political Constitution which was based on the broadest republican principles, and which provided for free schools, a free press, a complete subjugation of the ecclesiastical to the civil authority, and universal religious toleration—a Constitution which, with some later amendments, is still the organic law of Mexico. Such a reform could not, and at the time did not, triumph over the privileged classes, the Church, the aristocracy, and the military leaders, and, although embodied in the form of law, remained in abeyance.

But the Church and the aristocracy at the same time did not fail to recognize that, if Juarez and his party ever attained political ascendency, their property and privileges would be alike imperiled.

The subversion of the so-called Republic of Mexico, with its unstable government and frequent revolutions, and its replacement with an empire, backed by the then apparently invincible arms of France, and with one of the Catholic princes of Europe on the throne, were,

therefore, most acceptable to the Mexican Church and its adherents; and in Maximilian of Austria they thought they had found a man after their own heart.

He was a man of elegant presence, winning manners, and of much refinement and culture; and these qualities, with undoubted personal courage, contributed to give him a certain amount of personal popularity and sympathy. But he was, nevertheless, in all matters of government, always a representative of the highest type of absolutism or imperialism, and in devotion to the Catholic Church an extremist, even almost to the point of fanaticism. The first of these assertions finds illustration in his establishment of a court, with orders of nobility, decorations, and minute ceremonials; the construction and use of an absurd state carriage—modeled after the style of Louis XIV—and still shown in the National Museum; and worse, by the proclamation and execution of an order (which subsequently cost Maximilian his own life), that all republican officers taken prisoner in battle by the imperialists should be summarily executed as bandits; and, second, by his walking barefoot, on a day of pilgrimage, all the way over some two or three miles of dusty, disagreeable road, from the city of Mexico to the shrine of the Virgin at Guadalupe.

When the attitude and demand of the United States, on the termination of the rebellion, induced the withdrawal of the French forces from Mexico, Maximilian, at the suggestion of Louis Napoleon, prepared to abdicate; and, in October, 1866, even commenced his journey to Vera Cruz, with the intent of embarking from the country. Unfortunately for himself, however, he was persuaded by the Church party, under assurances of their ability to support him, to return to the city of Mexico and resume his government. But the attempt was hopeless, and culminated some six months later in his capture and execution by the republican forces, and with the downfall of the "Maximilian" or the "imperial" government, Juarez became the undisputed, and also, to all intents and purposes, the absolute, ruler of the country.

This portion of the more recent history of Mexico has been detailed somewhat minutely, because the series of events embraced in it led up to and culminated in an act of greater importance, than anything which has happened in the country since the achievement of its independence from Spanish domination. For no sooner had Juarez obtained an indorsement of his authority as President, by a general election, than he practically carried out with the co-operation of Congress, and with an apparent spirit of vindictiveness (engendered, it has been surmised, by the memory of the oppressions to which his race had been subjected), the provisions of the Constitution which he had been instrumental in having adopted in 1857. The entire property of the Mexican Church was at once "nationalized" (a synonym for confiscation) for the use of the state. Every convent, monastic institution, or religious house was closed up and devoted to

secular purposes ; and the members of every religious society, from the Jesuits to the Sisters of Charity, who served in the hospitals or taught in the schools, were banished and summarily sent out of the country. And so vigorously and severely is the policy of subjugating the ecclesiastical to the civil authority, which Juarez inaugurated in 1857, still carried out, that no convent or monastery now openly exists in Mexico ; and no priest or sister, or any ecclesiastic, can walk the streets in any distinctive costume, or take part in any religious parade or procession ; and this in towns and cities where, twenty years ago or less, the life of a foreigner or skeptic who did not promptly kneel in the streets at the "procession of the host," was imperiled. Again, while Catholic worship is still permitted in the cathedrals and in a sufficient number of other churches, it is clearly understood that all of these structures, and the land upon which they stand, are absolutely the property of the Government, liable to be sold and converted to other uses at any time, and that the officiating clergy are only "tenants at will." Even the ringing of the church-bells is regulated by law. All those rites, furthermore, which the Catholic Church has always "classed as among her holy sacraments and exclusive privileges, and the possession of which has constituted the chief source of her power over society, are also now regulated by civil law. The civil authority registers births, performs the marriage ceremony, and provides for the burial of the dead ; and while the Church marriage ceremonies are not prohibited to those who desire them, they are legally superfluous, and alone have no validity whatever." (See "Report on Church and State in Mexico to the State Department," by Consul-General Strother, December, 1883.)

Such an achievement as has been here briefly chronicled, was in every respect analogous to, and was as momentous to Mexico as the abolition of slavery was to the United States. Like slavery in the latter country, the Catholic Church had become, as it were, incorporated into the fundamental institutions of Mexico since its first invasion and conquest by the Spaniards. It had the sole management of all the educational institutions and influences of the country ; it held, in the opinion of a great majority of the people, the absolute control of the keys of heaven and hell ; it had immense wealth, mainly in the form of money ready to loan, buildings in the cities, and *haciendas* or estates in the country, and all the influences which wealth brings. And, even when Mexico achieved her independence, the influence of the Church was so little impaired by the accompanying political and social convulsions, that the national motto or inscription which the new state placed upon its seal, its arms, and its banners, was "*Religion, Union, and Liberty.*"

Except, therefore, for the occurrence of a great civil war, which convulsed the whole nation ; and in which the Church, after favoring a foreign invasion, and placing itself in opposition to all the patriotic,

liberty-loving sentiment of the country, had been signally beaten, its overthrow, as was the case with slavery in the United States, would not seem to have been possible. And even under the circumstances, it is not a little surprising and difficult of explanation, that a government could have arisen in Mexico strong enough and bold enough to at once radically overthrow and humiliate a great religious system, which had become so powerful, and had so largely entered into the hearts and become so much a part of the customs and life of its people; and that every subsequent national administration and party has now for a period of nearly twenty years unflinchingly maintained and executed this same policy.

Mr. David H. Strother ("Porte Crayon"), our late consul-general at Mexico, who has studied the matter very carefully, suggests that an explanation may be found in the character of the Indian races of Mexico, who constitute the bulk of the population, and "whose native spirit of independence predominates over all other sentiments." He also throws out the opinion that "the aborigines of the country never were completely Christianized; but, awed by force, or dazzled by showy ceremonials, accepted the external forms of the new faith as a sort of compromise with the conquerors." And he states that he has himself recently attended "religious festivals where the Indians assisted, clothed and armed as in the days of Montezuma, with a curious intermingling of Christian and pagan emblems, and ceremonies closely resembling some of the sacred dances of the North American tribes." It is also asserted that, on the anniversaries of the ancient Aztec festivals, garlands are hung upon the great stone idol that stands in the court-yard of the National Museum, and that the natives of the mountain villages sometimes steal away on such days to the lonely forests or hidden caves, to worship in secret the gods of their ancestors. But, be the explanation what it may, it is greatly to the credit of Mexico, and one of the brightest auguries for her future, that after years of war, and social and political revolutions, in which the adherents both of liberty and absolutism have seemed to vie with each other in outraging humanity, the idea of a constitutional government, based on the broadest republican principles, has lived, and, to as large an extent as has perhaps been possible under the circumstances, practically asserted itself in a national administrative system.

When the traveler visits the cities of Mexico, and sees the number and extent of the convents, religious houses, and churches, which, having been confiscated, are either in the process of decay or occupied for secular purposes; and, in the country, has pointed out to him the estates which were formerly the property of the Church, he gets some realization of the nature of the work which Juarez had the ability and courage to accomplish. And when he further reflects on the numbers of idle, shiftless, and certainly to some extent profligate people, who tenanted or were supported by these great properties, and

who, producing nothing and consuming everything, virtually lived on the superstitions and fears of their countrymen—which they at the same time did their best to create and perpetuate—he no longer wonders that Mexico and her people are poor and degraded, but rather that they are not poorer and more degraded than they are.

What amount of property was owned by the Mexican Church and clergy previous to its secularization is not certainly known (at least by the public). It is agreed that they at one time held the titles to all the best property of the republic, both in city and country; and there is said to have been an admission by the clerical authorities to the ownership of eight hundred and sixty-one estates in the country, valued at $71,000,000; and of twenty-two thousand lots of city property, valued at $113,000,000; making a total of $184,000,000. Other estimates, more general in their character, are to the effect that the former aggregate wealth of the Mexican Church can not have been less than $300,000,000; and, according to Mr. Strother, it is not improbable that even this large estimate falls short of the truth; "inasmuch as it is admitted that the Mexican ecclesiastical body well understood the value of money as an element of power, and, as bankers and money-lenders for the nation, possessed vast assets which could not be publicly known or estimated." Notwithstanding also the great losses which the Church had undoubtedly experienced prior to the accession of Juarez in 1857, and his control of the state, the annual revenue of the Mexican clergy at that time, from tithes, gifts, charities, and parochial dues, is believed to have been not less than $22,000,000, or more than the entire aggregate revenues of the state derived from all its customs and internal taxes. Some of the property that thus came into the possession of the Government was quickly sold by it, and at very low prices; and, very curiously, was bought, in some notable instances, by other religious (Protestant) denominations, which, previous to 1857, had not been allowed to obtain even so much as tolerance or a foothold in the country. Thus, the former spacious headquarters of the order of the Franciscans, with one of the most elegant and beautifully proportioned chapels in the world, within its walls, and fronting in part on the Calle de San Francisco, the most fashionable street in the city of Mexico, was sold to Bishop Riley and a well-known philanthropist of New York, acting for the American Episcopal missions, at an understood price of thirty-five thousand dollars, and is now valued at over two hundred thousand dollars. In like manner the American Baptist missionaries have gained an ownership or control, in the city of Puebla, of the old Palace of the Inquisition; and in the city of Mexico, the former enormous Palace of the Inquisition, is now a medical college; while the Plaza de San Domingo, which adjoins and fronts the Church of San Domingo, and where the *auto-da-fe* was once held, is now used as a market-place. A former magnificent old convent, to some extent reconstructed and repaired, also affords quar-

ters to the National Library, which in turn is largely made up of spoils gathered from the libraries of the religious "orders" and houses. The national Government, however, does not appear to have derived any great fiscal advantage from the confiscation of the Church property, or to have availed itself of the resources which thus came to it for effecting any marked reduction of the national debt. Good Catholics would not buy "God's property" and take titles from the state; and so large tracts of land, and blocks of city buildings, passed, at a very low figure, into the possession of those who were indifferent to the Church, and had command of ready money; and in this way individuals, rather than the state and the great body of the people, have been benefited.

Having thus briefly glanced at the physical condition and political and social experiences of Mexico, we are now prepared to discuss the economic condition of the country, its prospect for industrial development, and its possible commercial importance and future trade relations with the United States.

Population.—The element of first importance, and therefore the one entitled to first consideration in endeavoring to forecast the future of Mexico, is undoubtedly its population; the object alike for improvement, and the primary instrumentality by which any great improvement in the condition of the country can be effected. Whatever may be its aggregate—ten or twelve millions—it is generally agreed that about one third of the whole number are pure Indians, the descendants of the proprietors of the soil at the time of its conquest by the Spaniards; a people yet living in a great degree by themselves, though freely mingling in the streets and public places with the other races, and speaking, it is said, about one hundred and twenty different languages or dialects. Next, one half of the whole population are of mixed blood—the mestizos—of whose origin nothing, in general, can be positively affirmed, further than that their maternal ancestors were Indian women, and their fathers descendants of the Caucasian stock. They constitute the dominant race of the Mexico of to-day—the rancheros, farmers, muleteers, servants, and soldiers—the only native foundation on which it would seem that any improved structure of humanity can be reared. Where the infusion of white blood has been large, the mestizos are often represented by men of fine ability, who take naturally to the profession of arms and the law, and distinguish themselves. But, on the other hand, no small proportion of this race—the so-called "leperos"—are acknowledged by the Mexicans themselves to be among the lowest and vilest specimens of humanity in existence; a class exhibiting every vice, with hardly the possession of a single virtue. The remaining sixth of the population of Mexico are Europeans by birth or their immediate descendants, the Spanish element predominating. The national language also is Spanish—a language not well

fitted for the uses and progress of a commercial nation; and which will inevitably constitute a very serious obstacle in the way of indoctrinating the Mexican people with the ideas and methods of overcoming obstacles and doing things which characterize their great Anglo-Saxon neighbors. It should also be borne in mind that a language is one of the most difficult things to supplant in the life of a nation through a foreign influence. The Norman conquest of England, although it modified the Saxon language, could not substitute French; neither could the Moors make Arabic the language of Spain, although they held possession of a great part of the country for a period of more than seven centuries. It seems certain, therefore, that Spanish will continue to be the dominant language of Mexico until the present population is outnumbered by the Americans—a result which may occur before a very long time in the northern States of Mexico, where the population at present is very thin, but which is certainly a very far-off contingency in the case of Central Mexico.

Of the present population of Mexico, probably three quarters, and possibly a larger proportion—for in respect to this matter there is no certain information—can not read or write, possess little or no property, and have no intelligent ideas about civil as contradistinguished from military authority, of political liberty, or of constitutional government.

It is difficult, in fact, to express in words, to those who have not had an opportunity of judging for themselves, the degraded condition of the mass of the laboring classes of Mexico. The veil of the picturesque, which often suffices to soften the hard lines of human existence, can not here hide the ugliness and even hideousness of the picture which humanity exhibits in its material coarseness and intellectual or spiritual poverty. The late consul-general Strother, who, as a citizen of one of our former slaveholding States, is well qualified to judge, expresses the opinion, in a late official report (1885), that the scale of living of the laboring classes of Mexico "is decidedly inferior in comfort and neatness to that of the negroes of the Southern (United) States when in a state of slavery. Their dwellings in the cities are generally wanting in all the requirements of health and comfort—mostly rooms on the ground-floor, without proper light or ventilation; often with but a single opening (that for entrance), dirt floors, and no drainage. In the suburbs and in the country, the dwellings in the cold regions are adobe; and in the temperate or warm regions mere huts of cane, or of stakes wattled with twigs, and roofed with corn-stalks, plantain-leaves, or brush." In such houses of the common people there is rarely anything answering to the civilized idea of a bed, the occupants sleeping on a mat, skin, or blanket on the dirt floor. There are no chairs, tables, fireplace, or chimney; few or no changes of raiment; no washing apparatus or soap, and in fact no furniture whatever, except a flat stone with a stone roller to grind their corn, and a variety of earthen vessels to hold their

food and drink, and for cooking (which last is generally performed over a small fire, within a circle of stones outside, and in front, of the main entrance to the dwelling). The principal food of all these people is Indian corn, in the form of the so-called *tortilla*, which is prepared by placing a quantity of corn in a jar of hot water and lime (when it can be got) to soak overnight; the use of the lime being to soften the corn. When it is desired to use it, the grain is taken out and ground by hand on the stone and the roller before mentioned, into a kind of paste, and then slightly dried or baked on an earthen tray or pan over a small fire. Everybody in Mexico is said to eat *tortillas*, and their preparation, which is always assigned to the women, seems to employ their whole time, "to the exclusion of any care of the dwelling, their children, or themselves." Foreigners, especially Americans, find them detestable. Another standard article of Mexican diet is boiled beans (*frijoles*). Meat is rarely used by the laborers, but, when it is obtainable, every part of the animal is eaten. Peppers, both green and red, mixed with the corn-meal or beans, are regarded as almost indispensable for every meal, and, when condensed by cooking, are described by one, who obviously speaks from experience, as forming "a red-hot mixture whose savage intensity is almost inconceivable to an American. . . . A child of six or seven years old will eat more of this at a meal than most adult Americans could in a week—eating it, too, without meat or grease of any kind; merely folding up the *tortilla* of wheat or corn-meal, dipping up a spoonful of the terrible compound with it, and hastily biting off the end, for fear some of the precious stuff should escape. Should one be fortunate enough to have anything else to eat, these *tortillas* serve as plates, after which service the plates eaten."

With all this, the agricultural laborers of Mexico, both Indians and mixed bloods, are almost universally spoken of as an industrious, easily managed, and contented people. By reason of the general mildness of the climate, the necessary requirements for living are fewer than among people inhabiting the temperate and more northern latitudes, and consequently poverty with them does not imply extreme suffering from either cold or starvation. When their simple wants are satisfied, money with them has little value, and quickly finds its way into the pockets of the almost omnipresent *pulque* or "lottery-ticket" sellers, or the priest. "If they are too ready to take a hand against the Government at the call of some discontented leader, it is not because they are Indian or Mexican, but because they are poor and ignorant."

One noticeable peculiarity of the Mexican laborer is the strength of his local attachments, and it is in rare instances only that he voluntarily emigrates from the place of his nativity. This circumstance found a curious illustration in the experience of the recent railroad constructions in Mexico, where the builders found that they could rely

only upon the labor in the immediate neighborhood of their line of construction; and that, generally, neither money nor persuasion would induce any great numbers of these people to follow their work any distance from their native fields and villages. In those instances where temporary emigration was effected, the laborers insisted on carrying their families with them. The Government also recognizes to a certain extent this peculiarity in their army movements; and, whenever a company or regiment moves, the number of women—wives of the soldiers—accompanying seems almost absurdly numerous. They, however, represent, and to some extent supply, the place of the army commissariat.

In short, what Mexico is to-day, socially and politically, is the natural and legitimate sequence, and exactly what might have been expected from the artificial conditions which for more than three centuries have been forced upon her; and history has never afforded such a striking, instructive, and pitiful illustration of the effect upon a country and a people, of long-continued absolutism and tyranny in respect to both government and religion. It is true that Spain, if called to plead at the bar of public opinion, might point to her own situation and decadence as in the nature of judgment confessed and punishment awarded. But what has the Church, in whose hands for so many years was exclusively vested the matter of education, and which lacked nothing in the way of power and opportunity, to say to the appalling depths of ignorance in which she has left the Mexican people; an ignorance not confined to an almost entire lack of acquaintance with the simplest elements of scholastic learning—reading, writing, and the rules of common arithmetic—but even of the commonest tools and mechanical appliances of production and civilization? But, wherever may be the responsibility for such a condition of things, the conclusion seems irresistible that, against the moral inertia of such an appalling mass of ignorance, the advancing waves of any higher civilization are likely to dash for a long time without making any serious impression.

Educational Efforts and Awakening in Mexico.—It is, however, gratifying to be able to state that at last the leading men of Mexico have come to recognize the importance of popular education; and it is safe to say that more good, practical work has been done in this direction within the last ten years than in all of the preceding three hundred and fifty. At all of the important centers of population free schools, under the auspices of the national Government, and free from all Church supervision, are reported as established; while the Catholic Church itself, stimulated, as it were, by its misfortunes, and apparently unwilling to longer rest under the imputation of having neglected education, is also giving much attention to the subject; and is said to be acting upon the principle of immediately establishing two schools wherever, in a given locality, the Government, or any of the Protestant denominations, establish one. In several of the national

free schools visited by the writer, the scholars, mainly girls, appeared bright and intelligent, the teachers (females) competent, and the text-books modern. The language of instruction was, of course, Spanish, but a greater desire than ever before to learn English is reported, and it is now (contrary to former custom) generally taught in preference to French. Industrial schools, to which boys are appointed from different sections of the country, analogous to the system of appointments in the United States for West Point and Annapolis, have also been established by the Government. One of the most interesting of these, and for the promotion of which the Mexican Central Railroad corporation have co-operated, exists at Guadalupe, about five miles from the city of Zacatecas. Here, in a large and well-preserved convent structure, confiscated by the Government and appropriated for school purposes, some two or three hundred Mexican boys are gathered, and practically taught the arts of spinning and weaving, printing, carpentering, instrumental music, leather-work, and various other handicrafts; while, in close contiguity, and in striking contrast with the poverty of the surrounding country, the ecclesiastical authorities are expending a large amount of money—the proceeds of a legacy of a rich Mexican mine-proprietor—in reconstructing and decorating in a most elaborate manner the church, which was formerly a part of the convent, and which has been left in their possession.

The Federal Government also maintains national schools at the capital, of agriculture, medicine, law, and engineering; a Conservatory of Music, an Academy of Fine Arts, a National Museum and a National Library; together with institutions for the blind, deaf and dumb, the insane, for the reformation of young criminals, and such other systematic charities as are common in enlightened communities. Most of these institutions are located in old and spacious ecclesiastical edifices which have been "nationalized"; and the means for their support seem to be always provided, although the Mexican treasury is rarely or never in a flourishing condition. At the same time it is almost certain that all these laudable efforts on the part of the Government to promote education and culture have thus far worked down and affected to a very slight extent the great mass of the people. But it is, nevertheless, a beginning.

After all, however, as the stability of any form of government and the maintenance of domestic tranquillity with such a population as exists in Mexico, is obviously contingent on the maintenance of a strong, well-organized, and disciplined army, the first care of the central Government is naturally to promote military rather than secular education; and, accordingly, the National Military School, located at Chapultepec, and modeled after the best military schools of Europe, is in the highest state of efficiency. The system of instruction and the text-books used are French; and the *personnel* of the school, both officers and cadets, will compare favorably with anything that can be

seen at West Point. The army maintained by Mexico is larger than that of the United States, and the rank and file seem to be possessed of all the physical qualities essential for the making of good soldiers. But it is upon the patriotism and intelligence of the officers in command of the army that the immediate future and prosperity of Mexico is dependent. The single fact, however, that the present Government and the most intelligent and influential people of Mexico have recognized the necessity of educating the masses of the people, and that probably the best that can be done under existing circumstances is being done, certainly constitutes the most hopeful and encouraging augury for the future of the republic.

THE GOVERNMENT AND SOCIAL FORCES OF MEXICO.—As might be expected from the existing conditions, the Government of Mexico—both Federal and State—although nominally constitutional and democratic, is not, and from the very nature of things can not be, other than personal, and is often in the highest degree arbitrary and despotic; in short, a military despotism under the form of a republic. For example, under date of February 15, 1886, the telegraph reports that the people of Coahuila are rejoicing over the fact that, after a term of a year and a half of military rule, the civil authorities are to resume control of the local government; but to this is added the following significant statement: "The policy of the civil government, however, will probably be identical with that pursued by the military, as the Governor-elect is a strong supporter of the Administration, and will accede to all the demands of the Federal Government."

No such thing as a popular assemblage, to discuss public questions of any kind, ever takes place in Mexico; and when, in the fall of 1884, a young member of the national Congress from Vera Cruz—Diaz Miron—ventured to oppose a scandalous proposition of the then President, Gonzales, for the readjustment of the claims of the English holders of the national bonds, he felt it necessary to preface his speech on the floor of the House of Representatives with words to the effect that he fully recognized that, in opposing the Administration, he probably forfeited all chance for future political preferment, even if he did not at once endanger his personal freedom. And such, probably, would have been to him the result, had not the students of the city of Mexico made the cause of Miron their own, and by organizing and assuming the aggressive, forced the Government to abandon their position.

Although there are plenty of newspapers in Mexico—some sixteen "dailies" in the city of Mexico alone—they have, as might be expected, but comparatively few readers, and apparently exist for some other purpose than that of reporting the "news." Only one journal in the country—"El Monitor Republicano"—a daily published in the city of Mexico, and representing the Liberal Opposition, claims a circulation as great as thirty-five hundred; and probably next to this in

circulation (twenty-five hundred reported) is the Church paper, "El Tiempo," which is bitter alike against the Americans and all their improvements, not excepting even their railroads. Of all the other papers, it is doubtful whether their average circulation ever reaches as large a figure as eight hundred.

The press of Mexico, furthermore, can hardly be said to be free; inasmuch as, when it says anything which the Government assumes to be calculated to excite sedition, the authorities summarily arrest the editor and send him to prison; taking care, however, in all such proceedings, to scrupulously observe what has been enacted to be law. Thus, during the past year (1885), the editor-in-chief of "El Monitor Republicano" has served out a sentence of seven months in the common penitentiary, for his criticisms upon the Government.

Public opinion in Mexico means simply the opinions of the large landed proprietors, the professions, the teachers, the students, and the army officers; comprising in all not more than from twenty-five to thirty thousand of the whole population. And it is understood that less than this number of votes were cast at the last presidential election, although the Constitution of Mexico gives to every adult male citizen of the republic the right to vote at elections and to hold office. Popular election in Mexico is, therefore, little more than a farce; and the situation affords another striking illustration of a fact which is recognized everywhere by the student of politics, that an uneducated people will not avail themselves of the right to vote as a matter of course, or recognize any sense of duty or responsibility as incumbent upon them as citizens. Such a condition of affairs obviously constitutes in itself a perpetual menace of domestic tranquillity: for, with no census or registration of voters, no scrutiny of the ballot-box except by the party in power; no public meetings or public political discussions; and no circulation of newspapers among the masses, no peacefully organized political opposition has a chance to exist. Such opposition as does manifest itself is, therefore, personal and never a matter of principles. The central Government for the time being nominates and counts in what candidates it pleases; and, if any one feels dissatisfied or oppressed, there is absolutely no redress to be obtained except through rebellion. Such has been the political experience of the Republic of Mexico heretofore; and although the recent construction of railways, by facilitating the transportation of troops, has strengthened the central Government, there is no reason to suppose that what has happened in the past will not continue to happen until the first essential of a free government—namely, free and intelligent suffrage on the part of the masses—is established in the country; and the day for the consummation of such a result is very far distant.

The present President of Mexico, Porfirio Diaz, is undoubtedly one of the ablest men who has ever filled the office of its chief executive. He is believed to have the interest of his country supremely at

heart; is free from the suspicion that has attached, and probably with justice, to so many of the Mexican Presidents, of using his power, through contracts and expenditures, to enrich himself illegitimately; and has appreciated the necessity and favored all efforts for establishing and extending popular education. It is not, furthermore, to be denied that many of the men associated with the present or recent administrations of Mexico are of very high character and fine abilities; the recent representative of Mexico in the United States, Señor Zamacona, and the present minister, Señor Romero, for example, being the peers of the representatives of any of the governments of the Old World.

DEVELOPMENT OF THE MORAL FACULTY.*

BY JAMES SULLY, M. A.

IT has been long disputed whether the moral faculty is innate and instinctive, or whether it is the result of experience and education. The probability is that it is partly the one and partly the other. The child shows from an early period a disposition to submit to others' authority, and this moral instinct may not improbably be the transmitted result of the social experience and moral training of many generations of ancestors. Yet, whatever the strength of the innate disposition, it is indisputable that external influences and education have much to do in determining the intensity and the special form of the moral sentiment. We have now to trace the successive phases of its development.

A consciousness of moral obligation arises in the first instance by help of the common childish experience of living under parental authority at the outset. The child's repugnance to doing what is wrong is mainly the egoistic feeling of dislike to or fear of punishment. By the effect of the principle of association or "transference," dislike to the consequences of certain actions might lead on to a certain measure of dislike to the actions themselves. And such an effort would greatly strengthen the innate disposition to submit to authority.

When the forces of affection and sympathy come into play, this crude germ of moral feeling would advance a stage. An affectionate child, finding that disobedience and wrong-doing offend and distress his mother or father, would shrink from these actions on this ground. Not only so, the promptings of sympathy would lead the child to set a value on what those whom he loves and esteems hold in reverence. In this way love and reverence for the father lead on naturally to love and reverence for the moral law which he represents, enforces, and in a measure embodies.

Even now, however, the love of right has not become a feeling for

* From "Elements of Psychology, with Special Applications to the Art of Teaching." In press of D. Appleton & Co.

the inherent quality of moral rightness; it is still a blind respect for what is enjoined by certain persons who are respected and beloved. In order that the blind, sympathetic regard may pass into an intelligent appreciation, another kind of experience is necessary.

Thrown with others from the first, a child soon finds that he is affected in various ways by their actions. Thus another child takes a toy from him or strikes him, and he suffers, and experiences a feeling of anger, and an impulse to retaliate. Or, on the contrary, another child is generous and shares his toys, etc., with him, and so his happiness is augmented, and he is disposed to be grateful. In such ways the child gradually gains experience of the effect of others' good and bad actions on his own welfare. By so doing his apprehension of the meaning of moral distinctions is rendered clearer. "Right" and "wrong" acquire a certain significance in relation to his individual well-being. He is now no longer merely in the position of an unintelligent subject to a command; he becomes to some extent an intelligent approver of that command, helping to enforce it, by pronouncing the doer of the selfish act "naughty," and of the kind action "good."

Further experience and reflection on this would teach the child the reciprocity and interdependence of right conduct; that the honesty, fairness, and kindness of others toward himself are conditional on his acting similarly toward them. In this way he would be led to attach a new importance to his own performance of certain right actions. He feels impelled to do what is right, e. g., speak the truth, not simply because he wants to avoid his parents' condemnation, but because he begins to recognize that network of reciprocal dependence which binds each individual member of a community to his fellows.

Even now, however, our young moral learner has not attained to a genuine and pure repugnance to wrong as such. In order that he may feel this, the higher sympathetic feelings must be further developed.

To illustrate the influence of such a higher sympathy, let us suppose that A suffers from B's angry outbursts or his greedy propensities. He finds that C and D also suffer in much the same way. If his sympathetic impulses are sufficiently keen he will be able, by help of his own similar sufferings, to put himself in the place of the injured one, and to resent his injury just as though it were done to himself. At the beginning he will feel only for those near him, and the objects of special affection, as his mother or his sister. Hence the moral importance of family relations and their warm personal affections, as serving first to develop habitual sympathy with others and consideration for their interests and claims. As his sympathies expand, however, this indignation against wrong-doing will take a wider sweep, and embrace a larger and larger circle of his fellows. In this way he comes to exercise a higher moral function as a disinterested spectator of others' conduct, and an impartial representative and supporter of the moral law.

The highest outcome of this habit of sympathetic indignation against wrong is a disinterested repugnance to wrong when done by the individual himself. A child injures another in some way, either in momentary anger or through thoughtlessness. As soon as he is able to reflect, his habit of sympathy asserts itself, and causes him to suffer with the injured one. He puts himself at the point of view of the child he has wronged, and from that point of view looks back on himself, the doer of the wrong, with a new feeling of self-condemnation. On the other hand, when he fulfills his duty to another or renders him a kindness, he gains a genuine satisfaction by imaginatively realizing the feelings of the recipient of the service, and so looking back on his action with complacency and approval.

When this stage of moral progress is reached, the child will identify himself with the moral law in a new and closer way. He will no longer do right merely because an external authority commands, or because he sees it to some extent to be his interest to do so. The development of the unselfish feelings has now connected an internal pain, the pang of self-condemnation, and of remorse, with the consciousness of acting wrongly ; and this pain, being immediate and certain, acts as a constant and never-failing sanction.

The higher developments of the moral sentiment involve not only a deepening and quickening of the feelings, but a considerable enlightenment of the intelligence. In order to detect the subtler distinctions between right and wrong, delicate intellectual processes have to be carried out. Rapidity and certainty of moral insight are the late result of wide experience, and a long and systematic exercise of the moral faculty on its emotional and intellectual side alike.

Since the moral feeling stands in a peculiarly close relation to the will, the practical problem of exercising and developing it is intimately connected with the education of the will and the formation of the moral character. This larger problem we have not yet reached, but we may even at this stage inquire into the best means of developing the moral sentiment regarded apart from its influence as a motive to action, and merely as an emotional and intellectual product.

Inasmuch as the government of the parent and the teacher is the external agency that first acts upon the germ of the moral sentiment, it is evident that the work of training the moral feelings and judgment forms a conspicuous feature in the plan of early education. The nature of the home discipline more particularly is a prime factor in determining the first movements of growth of the childish sense of duty. In order that any system of discipline may have a beneficial moral influence and tend in the direction of moral growth, it must satisfy the requirements of a good and efficient system. What these are is a point which will be considered later on. Here it must suffice to say that rules must be laid down absolutely, and enforced uniformly and consistently, yet with a careful consideration of circumstances and indi-

vidual differences. Only in this way will the child come to view the commands and prohibitions of his parent or his teacher as representing and expressing a permanent and unalterable moral law, which is perfectly impartial in its approvals and disapprovals.

The effect of any system of discipline in educating and strengthening the moral feelings and judgment will depend on the spirit and temper in which it is enforced. On the one hand, a measure of calm becomes the judicial function, and a parent or teacher carried away by violent feeling is unfit for moral control. Hence everything like petty personal feeling, as vindictiveness, triumph, and so forth, should be rigorously excluded.

On the other hand, the moral educator must not, in administering discipline, appear as a cold, impersonal abstraction. He must represent the august and rigorously impartial moral law, but in representing it he must prove himself a living personality capable of being deeply pained at the sight of wrong-doing. By so doing he may foster the love of right by enlisting on his side the child's warmer feelings of love and respect for a concrete personality. The child should first be led to feel how base it is to lie, and how cowardly to injure a weak and helpless creature, by witnessing the distress it causes his beloved parent or teacher. In like manner he should be led on to feel the nobility of generosity and self-sacrifice by witnessing the delight which it brings his moral teacher.

It is hardly necessary to add, perhaps, that this infusion of morality with a warm sympathetic reflection of the educator's feelings presupposes the action of that moral atmosphere which surrounds a good personality. The child only fully realizes the repugnance of a lie to his parent or teacher when he comes to regard him as himself a perfect embodiment of truth. The moral educator must appear as the consistent respecter of the moral law in all his actions.

The training of the moral faculty in a self-reliant mode of feeling and judging includes the habitual exercise of the sympathetic feelings, together with the powers of judgment. And here much may be done by the educator in directing the child's attention to the effects of his conduct. The injurious consequences of wrong-doing and the beneficent results of right-doing ought to be made clear to the child, and his feelings enlisted against the one and on the side of the other. Not only so, his mind should be exercised in comparing actions so as to discover the common grounds and principles of right and wrong, and also in distinguishing between like actions under different circumstances, so that he may become rational and discriminative in pronouncing moral judgment.

What is called moral instruction should in the first stages of education consist largely of presenting to the child's mind examples of duty and virtue, with a view to call forth his moral feelings as well as to exercise his moral judgment. His own little sphere of observation

should be supplemented by the page of history and of fiction. In this way a wider variety of moral action is exhibited, and the level of every-day experience is transcended. Such a widening of the moral horizon is necessary both for enlarging and refining the feeling of duty, and for rendering the meaning of moral terms deeper and more exact. And it stimulates the mind to frame an *ideal* conception of what is good and praiseworthy.

The problem of determining the exact relation of intellectual to moral culture is one which has perplexed men's minds from the days of Socrates. On the one hand, as has been remarked, the enlightenment of the intelligence is essential to the growth of a clear and finely discriminative moral sense. On the other hand, it is possible to exercise the intellect in dealing with the formal distinctions of morality without calling the moral faculty into full vital activity.

This practical difficulty presses with peculiar force when we come on to the later exercises of moral instruction. The full carrying out of the process of informing the moral intelligence naturally conducts to the more or less systematic exposition of the ideas and truths of ethics. An enlightened conscience is one to which the deepest grounds of duty have begun to disclose themselves, and which has approximated to a complete and harmonious ideal of goodness by a systematic survey and co-ordination of the several divisions of human duty and the corresponding directions of moral virtue and excellence. Something in the shape of ethical exposition is thus called for when the child reaches a certain point in moral progress. But the educator must be careful to make this dogmatic instruction supplementary to, and not a substitute for, the drawing forth of the whole moral faculty on its sensitive and on its reflective side alike by the presentation of living concrete illustrations of moral truth. Divorced from this, it can only degenerate into a dead formal exercise of the logical faculty and the memory.

The education of the moral sentiment is, as we have seen, carried out in part by the influence of the child's companions. To surround him with companions is not only necessary for his comfort, but is a condition of developing and strengthening the moral feelings, as the sentiment of justice, the feeling of honor, and so on. The larger community of the school has an important moral function in familiarizing the child's mind with the idea that the moral law is not the imposition of an individual will, but of the community. The standard of good conduct set up and enforced by this community is all authoritative in fixing the early directions of the moral judgment.

This being so, it is evident that the moral educator must take pains to control and guide the public opinion of the school. And in connection with this he should seek to counteract the excessive influence of numbers, and to stimulate the individual to independent moral reflection.

DE CANDOLLE ON THE PRODUCTION OF MEN OF SCIENCE.

By W. H. LARRABEE.

THE first edition of Alphonse de Candolle's "History of the Sciences and of Scientific Men during two Centuries,"* which was published in 1873, was speedily exhausted, and the book became, as the author says, a rarity in the library catalogues. A search for it two years ago revealed the fact that there was but one copy to be found in the European markets, and that was held at three times the ordinary price. Frequent references to the work as an authority, and many inquiries for it, made a second edition necessary, and it has appeared, with careful revisions and valuable additions, within the year. The primary object of the work was to study the influence of heredity in developing men of science; but it was obvious from the outset that this was only one of many factors that concurred in producing the result, and by no means always a predominant one. Hence the task became at once that of learning what influence was contributed by birth, and what by exterior circumstances, such as education, examples, institutions, etc. The mixture of the two categories is often inextricable, as Mr. Galton has remarked, but in many cases we may succeed in determining which one of them is predominant.

M. de Candolle precedes his principal study with general discussions of the subjects of heredity and selection, and of the operation of selection in the human species, to which he has added in the later edition of his book an account of his processes and the results of his newer investigations on heredity. The latter were made upon thirty-one persons belonging to sixteen different families in comfortable circumstances, and bore reference to 1,032 distinct traits of character, for each of which he also inquired into its presence or absence in either or both parents. These traits were arranged in four categories: external, 287; internal, 140; instinctive and sentimental, 410; and intellectual, 195. The general result of the examination was to show in a striking manner that heredity is the usual, general, and predominant law, in both sexes and various degrees for all the categories of characteristics not acquired. Other facts of more limited application were brought out. Interruption of heredity during one or more generations, or atavism, was rarely presented, and seemed to say, when it occurred, not that the particular trait was wanting, but that it was feebly accentuated, in the intermediate generations. The more prominent or influential the per-

* "Histoire des Sciences et des Savants depuis Deux Siècles." Preceded and followed by other studies on scientific subjects, particularly on "Heredity and Selection." By Alphonse de Candolle. Second edition, with Additions. Geneva, Basle, and Lyon: H. Georg. Pp. 594. 1885.

son, for good or bad, the more he appeared to exhibit pronounced and numerous characteristics in the category of instinctive feelings and intelligence. Some of these feelings in such cases appeared in the family for the first time. Women present fewer distinctive traits than men. All the distinctive characteristics, regarded in groups, are more freely transmitted by fathers than mothers. This is particularly the case with traits of intelligence ; probably because the characteristics in question are more strongly developed in the fathers. It is hard to learn whether characteristics acquired by education, reading, and example, and from social influences, such as patriotism, religious opinions, the point of honor, devotion to a dynasty, etc., are transmitted. Probably they rest on weak but native and transmissible bases, such as sociability for patriotism, timorousness and curiosity for religion, a submissive spirit for loyalty, etc. The external influences of education, example, and other factors, develop upon these bases sentiments which become very strong, and are perhaps easily transmissible. The characteristics most marked in an individual are ordinarily those which he derives from both parents, and they exhibit special force if they are derived from these and also from other ancestors. A curious element of hereditary influence in developing men addicted to high mental effort may be found in considering the condition of the clergy of a country. It is not indifferent, M. de Candolle observes, "whether some categories of the instructed, intelligent, and respectable public, be restricted to celibacy or not. Laying aside all dogmatism and views respecting the discipline of the clergy, the result, relative to instruction, is not the same for a country where there are, for example, forty or fifty thousand celibate ecclesiastics, or the same number of clergymen-fathers of families. Even if we reduce heredity in intellectual affairs to a minimum, the mere existence, in Protestant countries, of married pastors, assures the development, from year to year, of a certain number of educated persons who will exert a wholesome influence upon society." Thus, Agassiz, Berzelius, Boerhaave, Robert Brown, Camper, Clausius, Encke, Euler, Fabricius, Grew, Hansteen, Hartsoeker, Oswald Heer, Jenner, Linnæus, Mitscherlich, Olbers, Claus Rudbeck, W. P. Schimper, Studer, Schweizer, Arthur Young, Wargentin, Wollaston, and Würtz, among men of science ; a list that includes Hallam, Hobbes, Puffendorf, and De Sismondi, among publicists and historians ; Addison, Gessner, Ben Jonson, Lessing, Jean Paul Richter, Swift, Thomson, Wieland, Young, and Emerson, among poets and men of letters ; and Christopher Wren and David Wilkie, among artists, would not have existed if their fathers, Protestant pastors, had been Roman Catholic priests, or would not have been what they were had their education been defective.

These are examples of an external influence, operating in a country at large, to modify heredity of intellectual tendencies, or to work along with it. The special object of M. de Candolle's research is

to determine how far such external influences, peculiar to different countries, have had effect, during the past two centuries, on the development of the sciences by producing the men most eminent in them.

M. de Candolle takes as the criterion, in the selection of men to be subjects of his review, the judgment of the principal learned societies of Europe as expressed toward scientific men severally not of their own nations. He thus avoids possible errors of his own judgment, and those which might originate in the prejudices of any other persons by whose judgment he could be guided. The opinions expressed by those societies in the manner indicated are impartial, if any opinions can be. They may not be wholly just as to individuals, for not all the most deserving have received the notice of foreign societies, but, as averages, they are probably as fair as possible. The Royal Society of London is accustomed to name fifty foreign members from among the distinguished in all branches of science. The French Academy of Sciences confers the title of *Foreign Associate* on eight scientific men not of France, and has usually, also, on its general list of correspondents from forty to seventy foreigners. The societies of Germany and Italy likewise confer suffrages among those men whom they consider to have done the most for science in other countries than their own. Taking the lists of the foreign members of these societies as they stand at stated periods from 1666, when Huygens was elected a foreign associate of the French Academy of Sciences, down to the present, we have a large catalogue of names which the scientific world has united, as it were, to pronounce its greatest.

The first conclusion drawn from the analysis of the lists is that of the greater importance that has been attained during the last hundred years by the natural as distinguished from the mathematical and physical sciences. Another fact to be learned from them is the growing tendency to devotion to special branches. The Greek philosophers and those of the middle ages were interested in all branches. In the days of Leibnitz and Newton, two or three designations were needed to describe a philosopher's pursuits, as "astronomer and physicist," or "mathematician, astronomer, and physicist," and it might sometimes be necessary to add "linguist" or "poet." But science has now become too large for this. Single branches must absorb the whole attention of those who would be proficient in them. And the impossibility of rising in science while following a lucrative profession or pursuing a hobby is becoming daily more evident. In this may lie one of the reasons why Roman Catholic ecclesiastics appear to have given up scientific pursuits. The lists, till the end of the eighteenth century, included many names of Jesuits, monks, and abbés. In the present century we have only the Abbé Haüy and Father Secchi. The difference is also in part due to the changed condition of the clergy. The clerical names on the lists of the last centuries were chiefly taken from the

sedentary clergy, whose ecclesiastical duties were light. The number of clergy of this class has been greatly reduced since the French Revolution; and the bishops and parish priests of to-day have no time for science. The increasing specialization of scientific work is also seen in the separation, in natural history, between collectors and describers, and between those who make applications of science and those who work at original research; and a separation is growing up between teaching and purely scientific work. Dividing society into three classes—the aristocratic, the middle class, and the workers—the former appears to be most fruitful in proportion to its numbers in the development of scientific excellence; but the list of Frenchmen in the present century appears to show an inclination in favor of the middle and working classes. By the force of circumstances a life of research is one of abnegation, which can hardly be recommended to those who have no worldly goods; and the conferring of scholarships and fellowships upon poor students can hardly change the conditions to any great extent. It may result in making well-informed men and teachers, but many other circumstances and influences than a university education must concur to induce a young man to devote himself to investigation, to the discovery of truths, and the publication of his results. These come next under review.

The appearance on the Academy lists in several instances of the names of father and son or of members of the same family, and in numerous instances of persons whose fathers had made a good record in professional or scholastic life, suggests heredity; but it is not safe to build too much on the suggestion—at least not in its application to the specific talent. There are other factors than heredity in the family life of professional and scientific men to direct the attention of the children toward kindred pursuits to those of the father. Heredity has a considerable effect, but it consists chiefly in the transmission of tastes and faculties that are useful in such pursuits, rather than of superior aptitudes for particular branches. Further than this, it does not operate directly, except perhaps in the case of the mathematical sciences. The power of family influences under the direction of scholarly fathers to cultivate such tastes in youth is shown in the large proportion of the names of sons of Protestant pastors on the scientific rolls. The occupations of physicians and pharmacists are more directly scientific than that of the pastor, but the number of sons of members of those professions on the lists is much inferior to that of sons of pastors. The difference is ascribed to the more quiet and intimate life of the pastoral home, and to the direct and constant supervision which is exercised by the pastor over the training of his sons. Switzerland furnishes more instances than any other country of members of the same family on the academical lists. This is because Swiss youth, particularly the sons of pastors, pursue their studies at home, living in their own families, while in France and Italy they are taken away from

home at the age of attending college. This was particularly true in Switzerland in the last century and the first half of the present one, especially at Geneva and Basle, the towns which have furnished the largest proportion of *savants* connected by family ties.

Inquiring what personal traits contribute most to the making of a scientific man, a comparison is made of the characteristics possessed in common by four eminent men—Darwin, Linnæus, Cuvier, and the author's father, Augustin-Pyramus de Candolle. They all had heads larger than the ordinary size; strong and persistent will; curiosity for the examination of accessible things and of truths; great activity, exhibited in the walking excursions of Linnæus and De Candolle, the untiring industry of Darwin, and the constant occupation of Cuvier with his work, although he seemed to be phlegmatic; order, shown in their aptitude in classification; observing faculties, in which none could be superior to Darwin and Cuvier; freedom from any taste for metaphysics; sound judgment; excellent memory; great power of attention, and remarkable faculty for generalization. As points of difference, Darwin, Cuvier, and De Candolle were distinguished by amplitude of ideas, while Linnæus was narrow; Darwin and De Candolle were independent in opinion, Linnæus and Cuvier less so. None of the four had a natural taste for languages, but De Candolle and Darwin regretted that they knew so little of other languages than their own. Looking for the origin of the qualities they had in common, we find that Linnæus was the son of a country pastor, and grandson, through his mother, of another pastor. Cuvier, whose brother Frédéric was also a zoölogist, but less celebrated than he, was the son of a military officer, whose life does not throw any particular light on the origin of his distinctive characteristics. The De Candolle family were distinguished by an independence of judgment that compelled them to change the country of their residence, for opinion's sake, four times in three hundred years. These four naturalists were singularly favored by external circumstances. They were born in long-civilized countries; they received a Protestant education which did not repress their curiosity or the independence of their opinions; they found, at home and around them, good examples, counsels, and encouragement; and they studied in good schools.

Special or innate tastes are not as important as they appear to be, unless they prove persistent. In that case they are cultivated in after-life, and are remembered and spoken of. But those who have the same tastes in infancy and fail to cultivate them, forget them and never speak of them. Multitudes of children chase butterflies and make collections of shells or insects without becoming naturalists, or construct toy houses and machines without becoming architects or engineers. Some scientific men have also been poetasters or amateur dramatists in their youth. Other special tastes and antipathies have some influence, but they result as often from the circumstances of

sights, conversations, examples, or other incidents occurring in youth, as from descent.

In instruction much depends on exciting curiosity or keeping it active. If, within the family or the school, we put questions to a child, or place it in such conditions that it will ask questions, its curiosity is excited. If, on the other hand, we discourage and repress the inquisitive disposition, the impulses of curiosity are arrested, and the mind gradually bends toward indifference or timidity. "From the primary school to the university, the teaching may favor, contradict, or direct in one manner or another the inquisitive spirit of young people. Appropriate questioning, the repulsion of frivolous or inappropriate questions, approval of those which are serious, and the solution of which is possible to the pupil, speaking about things which are not yet discovered or comprehended, but the discovery of which by means of research and reflection is hopeful, a rare use of the principle of authority, which is opposed to scientific methods, are means which may be indicated to teachers as adapted to direct the minds of their pupils toward the higher region of the sciences. Those are not the most eloquent or the most lucid professors who excite inquisitive minds, but those rather whose teachings leave doubts and suggest questions. If they can tell the whole and still excite curiosity, it is well; but to provoke the efforts of the pupils by badly directed teaching is not as regrettable as it is thought to be. Especially in the mathematical sciences, in which it is so important for the student to fix his attention, a merely ordinary teacher often succeeds better than a very skillful one.* The worst teacher, in the author's opinion, is the one who represents science as finished. A point on which many of Mr. Galton's correspondents, in the course of his inquiries respecting the education of English scientific men have insisted, "is that of giving freedom and leisure to pupils who show strong tastes in their studies. As they are original, curious, and independent in disposition, they are not very fond of having tasks imposed upon them. They are often poor scholars, but they are scholars who have a future, and provision ought to be made for giving them special treatment. Unfortunately, the system of education in common is opposed to that; and this is one of the reasons why so many schools form mediocrities, without favoring individuals who are superior to the average."

In reading the biographies of the several foreign associates of the French Academy, it is often a matter of surprise to observe how mediocre were some of the instructors of illustrious men, and how many

* "They say," said the author to Regnault, professor in the École polytechnique of Paris, "that when you were young the school produced many more celebrated mathematicians and physicists than it does now. Is it true?" "Perhaps so," he answered. "Why?" "Because, you see, our principal professor of mathematics was so obscure, that the pupils had to meet after each lesson to go over it again. For some time I had to revise the exercise-books of my comrades. You can not imagine how it made me work."

who were pupils of the most celebrated professors held a secondary rank in science; and we have to admit that, while illustrious *savants* may give good instruction, good teaching does not make illustrious *savants*. A deplorable effect of instruction is to diminish originality, without some proportion of which quality a scientific man can not rise above the mean.

When we inquire what is the influence of religion upon the development of scientific men, we find that the non-Christian countries are completely foreign to the scientific movement. We have no right to conclude from this that one has to be a Christian to be distinguished in science, for there are many examples to contradict such an assertion. We can only say that the Christian religion has been favorable to science by its general influence upon civilization. We can at least affirm that it has been, in the modern epoch, the only religion which has coincided with a real scientific development. Between the divisions of Christendom, the advantage is vastly in favor of Protestantism. While the proportion of Protestant to Roman Catholic populations is one to one and a half, Europe, outside of France, has furnished four times as many Protestant as Roman Catholic foreign associates to the French Academy of Sciences. France, where most of the Roman Catholic scientific men reside, has furnished about an equal number of Protestant and Roman Catholic foreign members of the Royal Society of London. No English or Irish Roman Catholic name appears on the list of the French Academy, although that Church includes a fifth of the population of the United Kingdom. Austria is not represented there, and Roman Catholic Germany makes but a poor showing by the side of Protestant Germany. In Switzerland, where the Catholics are to the Protestants as one to one and a half, not one of the foreign associates is a Roman Catholic. A similar difference appears to exist as among Swiss, English, and Irish, of the two cults in the lists of the London and Berlin societies. The difference is not attributable to anything in the doctrines of the churches, but rather to the different attitude—direct or indirect—of their clergy toward education, according as it is their habit to prescribe by authority or to leave every one free to form his own opinion. The more we proceed in an authoritative way, the more we repress curiosity, the mother of science, and increase mental timidity. A population educated for many generations under the principle of authority naturally becomes timid in intellectual affairs. But a population habituated from infancy to scrutinize concerns which it is told are of the greatest importance, like those of religion, will not be afraid to examine purely scientific questions, and will know better how to proceed to the solution of them. The fact, already referred to, should not be forgotten, that a large number of distinguished men of science have been the sons of Protestant pastors. Remove from the list of *savants* of Protestant countries the names appertaining to this class, and we shall find the scientific standing of the

two cults as to the other names nearly equal. Thus, a rule of pure discipline, foreign to the doctrines and which has not always existed in the Church, has had bad consequences for science in Roman Catholic countries.

Classes of ideas, feelings, sympathies, and antipathies may be transmitted in families by imitation or tradition, and have great influence on the course of their members. They often result from some great event which has made a marked impression on the family ; and we may have among the number traditions favorable to the pursuit of science. Pointed examples are afforded of them in the history of some of the Protestant families who were expelled from Roman Catholic countries in the sixteenth, seventeenth, and eighteenth centuries. Among these are the nine Bernouillis, who were famous in mathematics or physics. Of the men of this class there have been eleven of the one hundred and one foreign associates of the French Academy—an enormous proportion for a total population of less than a million souls. If the same proportion had ruled among, say, the Germans at large, we should have had three hundred and thirty German foreign associates instead of twenty-three ; or in the United Kingdom, one hundred and thirty British associates instead of twenty-seven ; and ten of these eleven lived in Switzerland. We might increase this number if we could trace all the cases of descent from refugee mothers. The English Puritans, who emigrated to this country, had essentially the same dispositions and character with the French Protestant refugees of the sixteenth century. Their descendants, direct and indirect, in New England have also shown favorable tendencies toward sciences of every kind. They have given Franklin and Rumford to the European academies and have furnished other distinguished men of science and historians and men of letters in the United States. The current immigration to the United States, being composed chiefly of working-men, does not bear the promise of exercising influence on the progress of science. But if every emigrant-vessel carried only one such man as Nuttall, Agassiz, Engelmann, Marcou, or Pourtalès, we might expect different results. These men and others like them are already laying the foundations of good scientific traditions, and are adding their influence to that of the Pilgrims of New England.

Public opinion is beneficial or not, according as it encourages or gives the stamp of fashion to those tastes and aims which are congenial with scientific pursuits, or to the opposite ones. Form of government seems to exercise but little positive influence. Provided civilization is not destroyed by long seasons of revolutionary violence or wars, there is no reason for supposing that scientific work will be arrested in any country solely on account of its political *régime*. Customs are much more important, and also education and family traditions. The most favorable geographical situations are in the midst of civilized nations, in the temperate zone. Science does not prosper in

the equatorial and tropical regions, nor in the south of Europe as much as in the north and center.

Nationality is not intrinsically a factor in science. Nevertheless, some nations have in their geographical situation, their extent, language, customs, or other incidental circumstances, features which are more or less favorable to science than corresponding features in other nations. The rank in representation in the academies has fluctuated variously between England, France, and Germany during the two centuries, while the smaller nations, like Holland, Switzerland, and the Scandinavian states, have, in proportion to their population, more than held their own in the competition with them. Switzerland seems to hold an extraordinary and constant superiority. Some of the reasons for this have been already explained. Another reason is to be found in the fact, which is brought out in the investigation, that a small country is on the whole more favorable to science than a large one.

If public institutions could really furnish incitements to scientific researches and promote their success, large countries would have a manifest advantage. In other words, there should regularly be more illustrious *savants* to the million souls in a great nation than in a small one. The facts as revealed by statistics are of contrary import, and it is not impossible to divine why this is so. There are in a small country, so far as concerns science, two advantages which may afford ample offsets to the lucrative places and honorary distinctions of large countries. One of the advantages is the relatively smaller importance of all public functions. In a small country, the careers of the army, the magistracy, and the administration can offer only moderate temptations to youth who feel themselves capable. If they aspire to a European reputation, science is the best means within their reach by which to obtain it. The public comprehends this, and, as it desires the value of the country to be measured by some other standard than that of the extent of its territory, it gives a moral support to men who seek to distinguish themselves in affairs purely intellectual. And this support of opinion, which is quite sensible in very small states, like Denmark and the Swiss cantons, comprehends also the advantage that men of merit prefer to remain in their country; and they preserve there their good influence and their wholesome traditions, instead of removing to the capitals of great states.

Furthermore, small countries touch upon other states at all points, or are, we might say, all frontiers. One can not live in one of them without making frequent comparisons with the institutions, laws, and usages of adjacent countries. This alone is a cause of intellectual activity, and profits to the cultivation of science. The vicinity of national boundaries has also the excellent effect of rendering a complete tyranny impossible. It is very easy for persecuted persons to escape from a country of small extent and live at peace in an adjoining state. This has often been seen in Switzerland, and was observed in Germany

and Italy, when they were divided up into many small states. Then, when the fugitives have escaped into the other states, they can generally get along with the language and customs, which will not be far removed from their own. But, in a very large country, not only is it hard to escape, but if one expatriates himself he will be exposed to the annoyance of finding himself among populations speaking a different language, and having other habits than his own.

Of twenty conditions which M. de Candolle lays down as favorable and the opposite of them as decidedly unfavorable to the progress of science, Switzerland has all, and no unfavorable opposites ; Turkey all the unfavorable ones, and no favorable ones ; the United States all but four favorable, and the exceptions—want of a wealthy class, want of a leisurely class devoting themselves to scientific enjoyments, lack of museums, etc., and non-proximity of civilized countries—are neither grave nor characteristic, but only temporary.

Above all the conditions enumerated, and controlling them, is the superior condition, primarily requisite, that every individual shall be secured in the ability to do what he judges fit, provided he does no harm to another. The idea is commonly expressed by the two terms, security and liberty ; but, in fact, there can be no security without liberty, nor liberty without security. The terms complement one another. The favorable conditions appear as a whole to have accumulated in their most obvious form in a triangular space comprehended between Central Italy, Scotland, and Sweden, with a projection extending across the ocean to New England. This peculiar shaping is the result of historical causes, the chief of which are the three decisive movements for European civilization of the Renaissance, which originated in Tuscany ; the Reformation, which started in Germany ; and political liberty, which has been laboriously and slowly developed in England. Other very important factors or superior conditions are, that the race shall be European, or of European origin ; that a long selection shall have prepared a considerable number of families for intellectual labors ; that the climate shall not be one of depressing heat, and that the geographical situation shall not be too far removed from centers of intellectual culture.

If we inquire what have been the most important scientific discoveries—that is, those which have not been mere applications, but which have opened new fields of research—made during the last forty years, we shall find among them those of spectral analysis, the transformation of forces, the ancient extension of the glaciers, the antiquity of man and prehistoric studies, evolution and natural selection, alternating generations, and deep-sea explorations. These have all originated in Scandinavia, Central Germany, Switzerland, Northern France, or England, or in the countries which have been found to occupy the first places in the academical lists. If we extend the inquiry to fifty or sixty years back, we shall find the case substantially the same. The

countries all lie within the region which has been marked as governed by the most favorable conditions for science.

Very distinguished or illustrious men compose in a manner the framework of our history; but by their side we may see a considerable number who have perhaps contributed quite as much, by their collective efforts, to the continuous progress of science. There may be found in this category some very ingenious men, very industrious, and worthy to figure in the first ranks, but whom a premature death has removed from activity, who have been prevented from publishing, or who have been obliged to give most of their time to work which made no showing. The celebrities who shine in the full light are, in reality, the manifestation of the existence of a public well informed and friendly to research. Scientific work is, in fact, much more than it appears to be, collective. This is one of the reasons why particular countries and groups of population obtain a superiority over others, and keep it for centuries. One or two celebrated men may disappear, without the choice and progressive population of which they were the highest expression being annulled. A group which has once produced such illustrations of its vigor may at any time furnish others.

Under the present multiplication of scientific schools and societies, laboratories, museums, and establishments in which science is applied, thousands of persons are competing in scientific labors. The more this army of workers grows, the more should it have within itself inventive minds who will perfect processes and occasionally make discoveries. The average class of scientific men is now of higher quality, because it represents better teaching and more skill in practice; but there will always be above this medium rank better endowed and more active *savants*, or those who are more masters of their time and their persons. The popularization of science by means of books, periodicals, lectures, and societies, and the interest taken by all intelligent people in scientific matters, are of great advantage to the progress of knowledge, for specialists make recruits and easily find assistance in mediums thus disposed. The slow and costly movements of governments are not equal in value to the zealous and disinterested impulsion of the public. M. de Candolle's opinions respecting the influence of politics and government patronage on scientific pursuits are, in fact, very decidedly expressed. After showing how religious prepossessions, which are usually more positive, more firmly held, and more exclusive than any other kind of prejudices, may interfere with the free exercise of scientific thought, he observes that the incompatibility of political relations is still greater; for politicians defend, not what they believe to be true, but what appears practicable or possible to realize, and are subservient to the authority of chiefs and majorities. Politics agree well with the aims of those whose chief pursuit is that of material gain, for such men frequently have to use the same methods as politicians to succeed; but the person who is seeking for pure truth in his-

tory, in law, or in moral, natural, or other science, is out of his place in a political assembly. He would hardly go there except from motives of patriotism, or under a transitory, enthusiastic impulse, and would very soon find out that he did not belong there. How could he lend himself to the manœuvres of politicians? How, for example, could he trade off a principle against a railroad, a charitable foundation for an election? How could he consent to transactions between truth and falsehood, to the barter of opinions which is the rule in political affairs? Men of science are sometimes found in considerable numbers in political assemblies, but the others always do their best to make them ridiculous, and kill them off by giving them bad names. "As a rule," M. de Candolle adds, "governments too much confound teaching with progress in science. Many of them believe they have done everything when they have created schools and universities. They do not comprehend that they often do more harm than good by restricting these institutions in their methods, or in the choice of teachers. They do not know to what degree science lives on liberty and on the individual work of masters and pupils outside of the lessons. Sometimes they overcharge the professors with courses, examinations, or administrative details which deprive those who wish to work of the time to do so.* They pay but little attention to the encouragement of original publications, the sale of which at the book-stores is far from being remunerative, and even when they do anything in that way, it is awkwardly, and to poor purpose.

"The idea of constructing expensive buildings for universities, laboratories, etc., is now very much in vogue. Such munificence furthers some works and gives means of obtaining greater precision in experiments, but it discourages isolated investigators who have not the same resources, while researches at home are usually the best thought out and the most original." †

Absolute sovereigns have sometimes invited distinguished men to their capitals and bestowed their favors upon them. But this, after all, was only a way of changing the place of scientific culture, not of creating it. Generally, emigrations of *savants* have been useful to

* "At the moment of writing this phrase, I have before me letters of French, German, and Italian professors, lamenting that they can not work for science, because they are charged with hundreds of examinations which could be attended to just as well by persons whose time is less valuable."

† Haeckel has gone so far as to say that the scientific work of institutions and the intrinsic value of their publications stand in an inverse ratio to the magnitude of the buildings and the splendid appearance of their volumes. "I need only refer," he adds, "to the small and miserable institutes and the meager resources with which Baer in Königsberg, Schleiden in Jena, Johannes Müller in Berlin, Liebig in Giessen, Virchow in Würzburg, Gegenbaur in Jena, have not only each advanced their special science most extensively, but have actually created new spheres for them. Compare with these the colossal expenditures and the luxurious apparatus in the grand institutes of Cambridge, Leipsic, and other so-called great universities—what have they produced in proportion to their means?"

themselves, to science, and to the countries which have welcomed them, in proportion as rulers have had the good sense to leave them time to work.

Democracies encourage *savants* most by leaving them the widest liberty of opinion. They have furthermore the advantage of causing the separation from political life and public functions of those men who have taste for research, cabinet-work, independence of thought, and for the truth as set above popularity and material considerations, or for precisely those things which most further the advance of science. In general, whatever may be the form or the tendency of the government, men who cultivate science for itself should rather consider themselves fortunate if they are out of favor with the administration.

THE PROBLEM OF CRYSTALLIZATION.

By ALFRED EINHORN, Ph. D., M. E.

CRYSTALS are symmetrical forms bounded by plane surfaces. A surface is said to be plane or level when its nature is such as is exemplified in a sheet of water extending over dimensions very small when compared to the radius of the earth. Crystals occur abundantly ; they are generally diminutive and frequently microscopic in size, and therefore readily escape ordinary observation. Quite different in this respect are many forms caused by the rougher forces active in Nature, and analogous to crystals in the regularity of the shapes they assume. They are not unfrequently noted for their unique and startling appearance, as is instanced in the five-sided columns of basalt, known in some volcanic regions, and distinguished for their weird forms and the awe and superstition they give rise to among the inhabitants. Also many erosion figures resulting from the disintegrating action of water and air upon rocks. Many examples of this category may be seen in the scenic displays of unexcelled grandeur afforded by our far West. Not to these, but to a more commonplace phenomenon, I will now direct the attention of the reader, inasmuch as it is, mechanically speaking, related to and will serve to elucidate the subject under consideration. I have reference to a heap of particles of more or less uniform size, arranging themselves under the influence of the pull or gravity of the earth, with the provision that their magnitude should be very small relative to that of the whole heap. Thus, a grain or gravel heap is an excellent example of the phenomenon I refer to, and it is a very remarkable circumstance that different heaps have the same slope, provided the character of the material and the support upon which they rest remain the same. The slope (the inclination of the sides of the heap with the horizon) is dependent upon the magnitude and shape of the particles, and also upon the nature of the support ; the whole sys-

tem being subject to the gravity of the earth, they assume certain definite relative positions which determine the magnitude of the slope. In order to insure the same slope, the particles need not necessarily be perfectly alike, but the average size and shape of a limited number of them, chosen at random, should be uniform throughout. It is clear that the nature of the support must influence the slope of the heap, for, resting on a polished surface like a plate of glass, the slope is less than when supported on a rough surface, as a wooden floor. Generally, in a heap of gravel the slope is different from that of a heap of grain, inasmuch as the dimensions and shape of the grain-particles differ materially from those of the gravel-particles. Bearing in mind that the magnitude of each of the particles is very small, when compared with that of the heap, and therefore their number very large, we have then considered a state of aggregation of particles, assuming certain definite outward forms, these being dependent upon known causes, which we can readily modify at will, so as to produce forms with stated slopes. Mechanically, this may be said to be entirely analogous to the problem of crystallization. There also we have states of aggregation of particles occurring in definite regular shapes of infinite variety, depending upon the nature of the substance and the nature of the force active between the ultimate particles, and the problem of crystallization is solved when the nature of the ultimate particles and of the force which holds them in their relative positions in the crystal has become known to us.

These are the actual questions under consideration, and before proceeding with their further discussion we cite some instances of crystallization of substances, rendered familiar to us, either through their utility in the arts and industries, or the recognized value they have by reason of their rarity and beauty. In Fig. 1 a crystal of diamond is

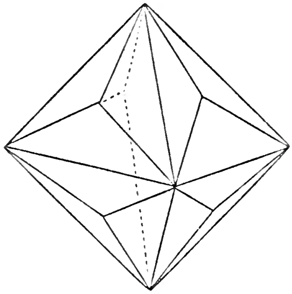

FIG. 1.

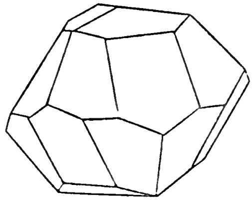

FIG. 2.

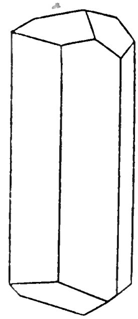

FIG. 3.

represented; the beauty and value of this gem are greatly enhanced by the cutting process; the remarkable property of cleavage, which all crystals possess to a greater or less extent, is well developed in the diamond, and skillfully utilized in its cutting. The form shown in the figure occurs at the Cape, and has a yellow tinge; the bluish-white

Brazilian diamond is preferred. A crystal of hematite (iron-ore) is shown in Fig. 2; it occurs in the Island of Elba, has an iron-black color and metallic luster, while its powder is reddish-brown like ordinary iron-rust. Fig. 3 is a crystal of calcite remarkable for its optical property of double refraction and its ready cleavability in certain directions; in substance it is the same as ordinary marble; in fact, the latter consists of microscopic crystals of calcite. In Fig. 4 we have a crystal of garnet, not unfrequently seen in the mica-slates of New York. A crystal of sulphur from Girgenti, Sicily, is shown in Fig. 5; that locality abounds in fine transparent crystals of this substance. Fig. 6 represents a cube

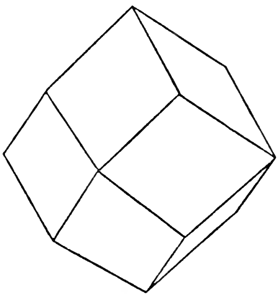

FIG. 4.

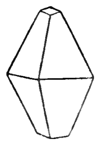

FIG. 5.

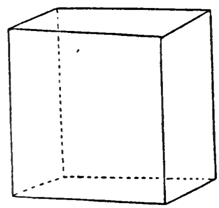

FIG. 6.

of native silver as found in Konigsberg, Norway; and, finally (Fig. 7), a crystal of cassiterite (tin-ore) from Cornwall, in England, which has also been discovered in this country in the Black Hills, Dakota Territory. There are seven systems of crystallization, differing in the relative magnitudes and directions of certain lines of symmetry, termed the axes of the crystal. In the first, second, and third systems, these lines bear the same inclination to one another, but their magnitudes are respectively equal in the first system (see Fig. 8) (here A A′, B B′,

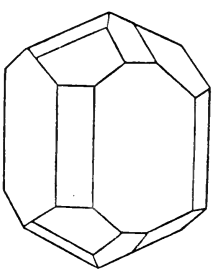

FIG. 7.

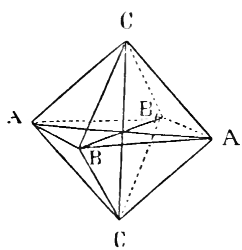

FIG. 8.

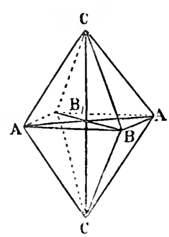

FIG. 9.

C C,′ are the three axes equal in magnitude and inclined at right angles to one another), equal in two of them in the second or dimetric system (Fig. 9) (here A A′ equals B B′, but C C′ is different from these), and unequal in all three axes in the third or trimetric system (Fig. 10) (here the axes A A′, B B′, and C C′, are all of unequal magnitudes, but their mutual inclinations in this as well as in the second system are equal).

In the three oblique systems the axes are partly or altogether obliquely inclined to one another, while their magnitudes are unequal. Fig. 11 is a crystal of the monoclinic system, and Fig. 12 of the triclinic system. The names of the different oblique systems indicate the mutual inclinations of the axes. Fig. 13 represents a crystal of the hexagonal system, which is allied in symmetry to the dimetric system; but there are four lines of symmetry, of which the three A A′, B B′, and C C′, lying in the same horizon, are equal in their mutual inclination and magnitude, while the fourth axis, D D′, is at right angles to these but different in magnitude.

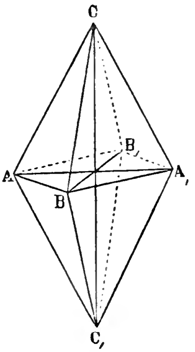

Fig. 10.

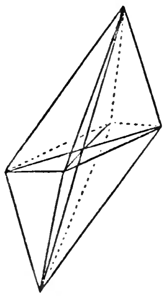

Fig. 11.

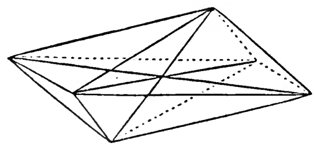

Fig. 12.

The reader will now have formed a tolerably correct idea of a crystal, and when it is borne in mind that crystallization is a widely diffused and essential property of matter, and also that the solution of this question has engaged some of the ablest minds of the century, the high purpose and importance of this investigation will perhaps become evident to him.

Now, the invariability of certain relations existing between the axes and the planes bounding crystal forms are geometrically similar, and are effects produced by causes similar to those which occasion the constancy of the slopes in heaps of the same material. In the heap of gravel considered above, the horizon was chosen as the reference plane—in the crystal the planes containing the lines of symmetry are selected as reference planes, whereby to gauge the inclination of the bounding surfaces. From our considerations of the heap of gravel, the reader will perceive the intimate connection between outward form and internal structure, and is in a measure prepared to follow deductions made from the one upon the other. Already in the remote infancy of mineralogy assumptions as to the internal structure of crystals were made to explain the axial relations alluded to. The assumption that the internal structure of a crystal is similar to, and in a measure identical with, the internal structure of a cannon-ball pile, is sufficient to

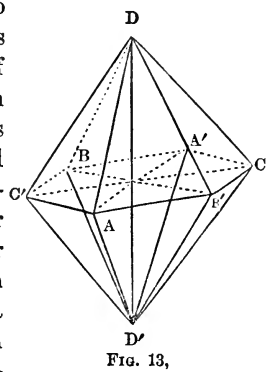

Fig. 13.

explain the axial relations observed in the first, second, and third systems of crystallization. In the first system the ultimate particles of the crystal are symbolized by the sphere, while in the second and third systems they are figures of oval form. The cannon-ball pile arrangement, or, as it is termed, the tetrad configuration, is represented in Fig. 14 (perspective of vertical circles of contact of the spheres); it derives this name from the fact that its type consists of four equal mutually touching spheres (Fig. 15). If in such an arrangement of particles sections are made in certain directions, we obtain the faces of the several crystal forms. In this manner the octahedral face (Fig. 16), the cubical face (Fig. 17), and the dodecahedral face (Fig. 18), have been obtained. In an octahedron, or in a cube, or in a dodecahedron, represented respectively in Figs. 8, 6, 4, and respectively composed of layers as indicated in Figs. 16, 17, 18, the ultimate particles have the same common arrangement, that is, the tetrad grouping. These forms, as has been shown above, all occur in nature; but as yet the most powerful microscope has been unable to dissolve a crystal face into its ultimate particles. Still, they are not insensibly small; their dimensions are shown to lie between certain limits, ascertained by combined computation and observation, and it is highly satisfactory that physicists have approximately obtained the same results in this direction, although the methods chosen were different. And it is the fact that we are dealing with invisibly small particles which renders the problem under consideration one of peculiar difficulty and interest. Instead of the tetrad configuration, there is a second grouping of particles, which would also serve to explain the observed axial relations of crystals. It is deduced from Fig. 19, by placing the layer of spheres marked *a* centrally over the layer marked *b*. But this grouping can not exist permanently in Nature; it is, as I have elsewhere shown, in a mechanical state similar to that of an exceedingly thin coin placed on its edge—the slightest effort, tending to upset the coin, would do so—it is what is termed a position of unstable equilibrium, and therefore can not exist permanently; the tetrad configuration, on the contrary, is in stable equilibrium.

We have thus already almost involuntarily introduced force as a factor in our considerations, and the deductions already made from outward form upon internal structure must necessarily also embrace considerations of the forces that the ultimate particles are subject to; and again, in order to bring the subject within the natural sphere of conception of the human mind, we will analyze the force transitions and the force law in a cannon-ball pyramid, subject to the gravity of the earth, preparatory to proceeding with the more remote and recondite subject of crystallization. In Fig. 14 it is clear that the weight of the top ball is distributed among the lower three, in the three direction-lines joining the centers of the top and three lower balls respectively. On examination of a pyramid composed of a larger number of balls,

we observe that every ball of the pyramid bears the weight only of those balls that are arranged in three lines parallel to upper edges of the pyramid respectively, and meeting in the center of the ball. Thus, in Figs. 15 *a* and 15 *b* are represented in plan the four layers of a pyramid of twenty balls. The ball *a*, of the lowest layer, can only receive the weights of the balls b_1 b_1 b_1 of the second layer, transmitted in direction-lines parallel respectively to the three upper edges of the pyramid (Fig. 14), namely, D A, D A_0, and D A_3. The ball *a* can not receive the weight of any other ball of the pyramid; it can not receive the weight of the topmost ball, *d*, inasmuch as the weight of this ball is transmitted only in the lines D A, D A_0, and D A_3, the three upper edges of the pyramid; nor can it receive the weight of the ball C of the third layer, for that is only transmitted in three lines, of which two, C A_1 and C A_3, can be seen in the figure. By a simple application of the physical principle known as the parallelogram of forces, we arrive at the deduction that all balls equidistant from the vertex of the pyramid are solicited by the same force; or, in other words, that every ball of the pyramid is repulsed from the vertex with a force proportional to its distance from the vertex, as a direct consequence of this stress distribution. At the vertex itself the repulsion is zero. The weight of the pyramid is uniformly distributed over its base; a result which can readily be verified by experiment, and is also a verification of the stated force law. Now, an exactly analogous action occurs among the invisibly small particles of a crystal. In the pyramid of balls, it is the pull of the earth upon each ball which is active; in the crystal it is the mutual attraction of the particles.

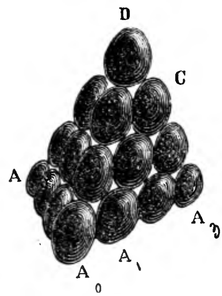

FIG. 14.

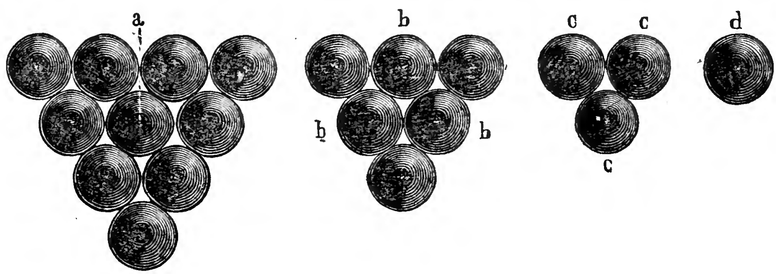

FIG. 15.

In the pyramid of balls, there are only three stress direction-lines respectively parallel to the upper edges of the pyramid, inasmuch as the pull of the earth acts only vertically downward, hence there is no weight transmission in the three horizontal direction-lines parallel to the basal edges respectively; in the crystal, however, there are

six stress direction-lines, inasmuch as the mutual forces between the ultimate particles of the crystal act in all the directions joining the centers of the particles respectively. That the stress can only be transmitted in six direction-lines is evident from the following consideration: In a pyramid of four balls (Fig. 15 *b*) we have evidently the six stress direction-lines joining the centers of the balls respectively. In case of a larger number of particles in contact, it is clear that in an octahedral face (Fig. 16) the stress can only be transmitted in three direction-lines, A A_1, B B_1, and C C_1, for there is no contact between the particles which would allow the stress to be transmitted in any other direction; in the cubical face (Fig. 17) there are but two stress direction-lines, D D_1 and E E_1, and in the dodecahedral face (Fig. 18) there is but one stress direction-line, F F_1; and generally on any particle in the tetrad configuration the stress can only be transmitted in six direction-lines, respectively parallel to the six edges of the pyramid. All this applies not only to the first or monometric system of crystallization, in which the ultimate particles are symbolized by the spherical form, but also to the dimetric and trimetric systems in which the ultimate particles are symbolized by an oval form. But this analogy between the pyramid of balls and crystals holds not only for the stress distribution, but extends also to the law of the forces active between the ultimate particles. In order to satisfy the equilibrium condition, the physical doctrine demands a unique law of force for a stated stress distribution, and elsewhere I have shown this law to be—Every particle is attracted to the center of the crystal with a force proportional to its distance from the center; while the law for the ball pyramid is—Every particle is repulsed from

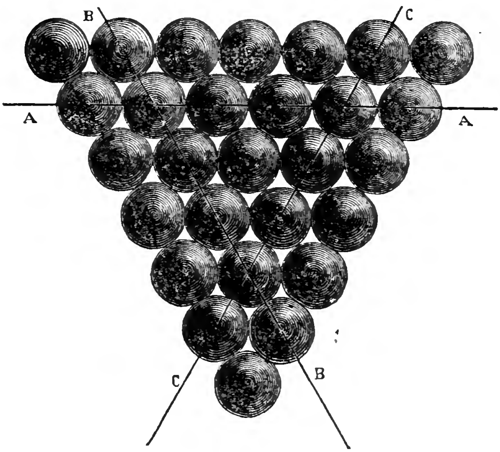

Fig. 16.

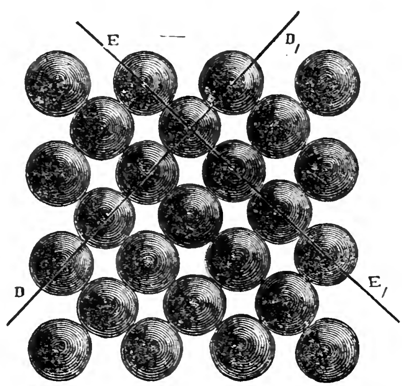

Fig. 17.

the vertex of the pyramid with a force proportional to its distance from the vertex.

The proper mathematical interpretation of the stated force law in crystals shows its perfect identity with the Newtonian law of gravitation, according to which every particle of the universe attracts every other particle, with a force proportional to the product of the masses, and inversely as the square of the distance. Thus, the symmetry, beauty, and definiteness displayed in the infinite variety of crystal forms have necessarily impressed themselves upon the observing mind, ever since the remote period of the dawn of the natural sciences, as the silent carriers of a law of profound influence upon the nature of substances. That this law, in obedience to which the planets are swept through space, should also regulate the position of the tiny crystal molecule, is a striking instance of the truism, in accordance with which the essences of things are not affected by their magnitude, and without which the human mind could not conceive the interaction of the forces of Nature.

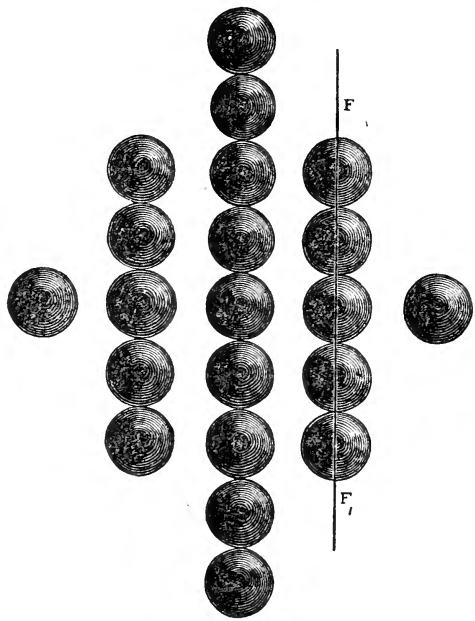

FIG. 18.

The stated law also governs the interaction of electrical *masses.* Now, the only reason why it applies to the ultimate particles of a crystal is their tetrad arrangement. Hence the tetrad grouping of the ultimate particles, and therefore crystallization, is caused by an agent which acts like electricity. Very probably it is electricity itself, as is evidenced by the electrical properties of certain crystal forms, which appear to establish an intimate causal connection between the structure of crystals and this agent. This is illustrated in many so-called hemimorphic forms: these are forms in which opposite ends of a crystal, instead of being bounded by faces of the same form, are bounded by faces belonging to different forms. This phenomenon occurs in

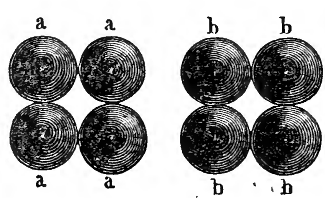

FIG. 19.

crystals of tourmaline, topaz, and calamine. The ends which show this peculiarity alternately exhibit positive and negative electricity—the one kind when the mineral is heating, and the other while it is cooling. The experiments of Faraday and Tyndall also indicate this causal connection. Thus the problem of crystallization may be said to have arrived at the stage of a partial solution, and the manner in which the result has been obtained clearly shows why an agent like electricity is the cause of crystallization ; it also shows a perfect definite relation existing between the intensity of this agent and the crystal form. When it is considered that difference in crystal form is, as a rule, associated with difference in chemical composition, it is easy to conceive how profoundly important this relation is in the chemism of substances. The intimate causal connection between electricity and chemical affinity is well accepted.

The law of the periodicity of the elements, discovered by the Russian chemist, Mendeljief ; the investigations of Kekule on the aromatic compounds, which throw a strong light upon their structure ; the law of Dulong and Petit, as to the constancy of the relation between the heat and atomic weight of the elements—all these give just grounds for the remark that, when brought into proper connection with the stated law of crystallization, an epoch may result in our knowledge of atoms.

THE FACTORS OF ORGANIC EVOLUTION.

By HERBERT SPENCER.

II.

THE growth of a thing is effected by the joint operation of certain forces on certain materials ; and when it dwindles, there is either a lack of some materials, or the forces co-operate in a way different from that which produces growth. If a structure has varied, the implication is that the processes which built it up were made unlike the parallel processes in other cases, by the greater or less amount of some one or more of the matters or actions concerned. Where there is unusual fertility, the play of vital activities is thereby shown to have deviated from the ordinary play of vital activities ; and conversely, if there is infertility. If the germs, or ova, or seed, or offspring partially developed, survive more or survive less, it is either because their molar or molecular structures are unlike the average ones, or because they are affected in unlike ways by surrounding agencies. When life is prolonged, the fact implies that the combination of actions, visible and invisible, constituting life, retains its equilibrium longer than usual in presence of environing forces which tend to destroy its equilibrium. That is to say, growth, variation, survival, death, if they are to be reduced to the forms in which physical science can recognize them,

must be expressed as effects of agencies definitely conceived—mechanical forces, light, heat, chemical affinity, &c.

This general conclusion brings with it the thought that the phrases employed in discussing organic evolution, though convenient and indeed needful, are liable to mislead us by veiling the actual agencies. That which really goes on in every organism is the working together of component parts in ways conducing to the continuance of their combined actions, in presence of things and actions outside; some of which tend to subserve, and others to destroy, the combination. The matters and forces in these two groups, are the sole causes properly so called. The words "natural selection," do not express a cause in the physical sense. They express a mode of co-operation among causes—or rather, to speak strictly, they express an effect of this mode of co-operation. The idea they convey seems perfectly intelligible. Natural selection having been compared with artificial selection, and the analogy pointed out, there apparently remains no indefiniteness: the inconvenience being, however, that the definiteness is of a wrong kind. The tacitly implied Nature which selects, is not an embodied agency analogous to the man who selects artificially; and the selection is not the picking out of an individual fixed on, but the continuance in an active state of such individual when others have been overthrown. Mr. Darwin was conscious of these misleading implications. In the introduction to his *Animals and Plants under Domestication* (p. 7) he says:—

"For brevity sake I sometimes speak of natural selection as an intelligent power; . . . I have, also, often personified the word Nature; for I have found it difficult to avoid this ambiguity; but I mean by nature only the aggregate action and product of many natural laws,—and by laws only the ascertained sequence of events."

But while he thus clearly saw, and distinctly asserted, that the factors of organic evolution are the concrete actions, inner and outer, to which every organism is subject, Mr. Darwin, by habitually using the convenient figure of speech, was, I think, prevented from recognizing so fully as he would otherwise have done, certain fundamental consequences of these actions.

Though it does not personalize the cause, and does not assimilate its mode of working to a human mode of working, kindred objections may be urged against the expression to which I was led when seeking to present the phenomena in literal terms rather than metaphorical terms—the survival of the fittest*; for in a vague way the first word, and in a clear way the second word, calls up an anthropocentric idea. The thought of survival inevitably suggests the human view of certain sets of phenomena, rather than that character which they have simply as groups of changes. If, asking what we really know of a plant, we ex-

* Though Mr. Darwin approved of this expression and occasionally employed it, he did not adopt it for general use; contending, very truly, that the expression Natural Selection is in some cases more convenient. See *Animals and Plants under Domestication* (first edition) Vol. I, p. 6; and *Origin of Species* (sixth edition) p. 49.

clude all the ideas associated with the words life and death, we find that the sole facts known to us are that there go on in the plant certain inter-dependent processes, in presence of certain aiding and hindering influences outside of it; and that in some cases a difference of structure or a favourable set of circumstances, allows these inter-dependent processes to go on for longer periods than in other cases. Again, in the working together of those many actions, internal and external, which determine the lives or deaths of organisms, we see nothing to which the words fitness and unfitness are applicable in the physical sense. If a key fits a lock, or a glove a hand, the relation of the things to one another is presentable to the perceptions. No approach to fitness of this kind is made by an organism which continues to live under certain conditions. Neither the organic structures themselves, nor their individual movements, nor those combined movements of certain among them which constitute conduct, are related in any analogous way to the things and actions in the environment. Evidently the word fittest, as thus used, is a figure of speech; suggesting the fact that amid surrounding actions, an organism characterized by the word has either a greater ability than others of its kind to maintain the equilibrium of its vital activities, or else has so much greater a power of multiplication that though not longer lived than they, it continues to live in posterity more persistently. And indeed, as we here see, the word fittest has to cover cases in which there may be less ability than usual to survive individually, but in which the defect is more than made good by higher degrees of fertility.

I have elaborated this criticism with the intention of emphasizing the need for studying the changes which have gone on, and are ever going on, in organic bodies, from an exclusively physical point of view. On contemplating the facts from this point of view, we become aware that, besides those special effects of the co-operating forces which eventuate in the longer survival of one individual than of others, and in the consequent increase through generations, of some trait which furthered its survival; many other effects are being wrought on each and all of the individuals. Bodies of every class and quality, inorganic as well as organic, are from instant to instant subject to the influences in their environments; are from instant to instant being changed by these in ways that are mostly inconspicuous; and are in course of time changed by them in conspicuous ways. Living things in common with dead things, are, I say, being thus perpetually acted upon and modified; and the changes hence resulting, constitute an all-important part of those undergone in the course of organic evolution. I do not mean to imply that changes of this class pass entirely unrecognized; for, as we shall see, Mr. Darwin takes cognizance of certain secondary and special ones. But the effects which are not taken into account, are those primary and universal effects which give certain fundamental characters to all organisms. Contemplation of an analogy will best

prepare the way for appreciation of them, and of the relation they bear to those which at present monopolize attention.

An observant rambler along shores, will, here and there, note places where the sea has deposited things more or less similar, and separated them from dissimilar things—will see shingle parted from sand; larger stones sorted from smaller stones; and will occasionally discover deposits of shells more or less worn by being rolled about. Sometimes the pebbles or boulders composing the shingle at one end of a bay, he will find much larger than those at the other: intermediate sizes, having small average differences, occupying the space between the extremes. An example occurs, if I remember rightly, some mile or two to the west of Tenby; but the most remarkable and well-known example is that afforded by the Chesil bank. Here, along a shore some sixteen miles long, there is a gradual increase in the sizes of the stones; which, being at one end but mere pebbles, are at the other end great boulders. In this case, then, the breakers and the undertow have effected a selection—have at each place left behind those stones which were too large to be readily moved, while taking away others small enough to be moved easily. But now, if we contemplate exclusively this selective action of the sea, we overlook certain important effects which the sea simultaneously works. While the stones have been differently acted upon in so far that some have been left here and some carried there; they have been similarly acted upon in two allied, but distinguishable, ways. By perpetually rolling them about and knocking them one against another, the waves have so broken off their most prominent parts as to produce in all of them more or less rounded forms; and then, further, the mutual friction of the stones simultaneously caused, has smoothed their surfaces. That is to say in general terms, the actions of environing agencies, so far as they have operated indiscriminately, have produced in the stones a certain unity of character; at the same time that they have, by their differential effects, separated them: the larger ones having withstood certain violent actions which the smaller ones could not withstand.

Similarly with other assemblages of objects which are alike in their primary traits but unlike in their secondary traits. When simultaneously exposed to the same set of actions, some of these actions, rising to a certain intensity, may be expected to work on particular members of the assemblage changes which they cannot work in those which are markedly unlike; while others of the actions will work in all of them similar changes, because of the uniform relations between these actions and certain attributes common to all members of the assemblage. Hence it is inferable that on living organisms, which form an assemblage of this kind, and are unceasingly exposed in common to the agencies composing their inorganic environments, there must be wrought two such sets of effects. There will result a universal likeness

among them consequent on the likeness of their respective relations to the matters and forces around; and there will result, in some cases, the differences due to the differential effects of these matters and forces, and in other cases, the changes which, being life-sustaining or life-destroying, eventuate in certain natural selections.

I have, above, made a passing reference to the fact that Mr. Darwin did not fail to take account of some among these effects directly produced on organisms by surrounding inorganic agencies. Here are extracts from the sixth edition of the *Origin of Species* showing this.

"It is very difficult to decide how far changed conditions, such as of climate, food, &c., have acted in a definite manner. There is reason to believe that in the course of time the effects have been greater than can be proved by clear evidence. . . . Mr. Gould believes that birds of the same species are more brightly coloured under a clear atmosphere, than when living near the coast or on islands; and Wollaston is convinced that residence near the sea affects the colours of insects. Moquin-Tandon gives a list of plants which, when growing near the sea-shore, have their leaves in some degree fleshy, though not elsewhere fleshy" (pp. 106-7). "Some observers are convinced that a damp climate affects the growth of the hair, and that with the hair the horns are correlated" (p. 159).

In his subsequent work, *Animals and Plants under Domestication*, Mr. Darwin still more clearly recognizes these causes of change in organization. A chapter is devoted to the subject. After premising that "the direct action of the conditions of life, whether leading to definite or indefinite results, is a totally distinct consideration from the effects of natural selection;" he goes on to say that changed conditions of life "have acted so definitely and powerfully on the organization of our domesticated productions, that they have sufficed to form new sub-varieties or races, without the aid of selection by man or of natural selection." Of his examples here are two.

"I have given in detail in the ninth chapter the most remarkable case known to me, namely, that in Germany several varieties of maize brought from the hotter parts of America were transformed in the course of only two or three generations." (Vol. ii, p. 277.) [And in this ninth chapter concerning these and other such instances he says "some of the foregoing differences would certainly be considered of specific value with plants in a state of nature." (Vol. i, p. 321.)] "Mr. Meehan, in a remarkable paper, compares twenty-nine kinds of American trees, belonging to various orders, with their nearest European allies, all grown in close proximity in the same garden and under as nearly as possible the same conditions." And then enumerating six traits in which the American forms all of them differ in like ways from their allied European forms, Mr. Darwin thinks there is no choice but to conclude that these "have been definitely caused by the long-continued action of the different climate of the two continents on the trees." (Vol. ii, pp. 281-2.)

But the fact we have to note is that while Mr. Darwin thus took account of special effects due to special amounts and combinations of agencies in the environment, he did not take account of the far more important effects due to the general and constant operation of these

agencies.* If a difference between the quantities of a force which acts on two organisms, otherwise alike and otherwise similarly conditioned, produces some difference between them ; then, by implication, this force produces in both of them effects which they show in common. The inequality between two things cannot have a value unless the things themselves have values. Similarly if, in two cases, some unlikeness of proportion among the surrounding inorganic agencies to which two plants or two animals are exposed, is followed by some unlikeness in the changes wrought on them ; then it follows that these several agencies taken separately, work changes in both of them. Hence we must infer that organisms have certain structural characters in common, which are consequent on the action of the medium in which they exist : using the word medium in a comprehensive sense, as including all physical forces falling upon them as well as matters bathing them. And we may conclude that from the primary characters thus produced there must result secondary characters.

Before going on to observe those general traits of organisms due to the general action of the inorganic environment upon them, I feel tempted to enlarge on the effects produced by each of the several matters and forces constituting the environment. I should like to do this not only to give a clear preliminary conception of the ways in which all organisms are affected by these universally-present agents, but also to show that, in the first place, these agents modify inorganic bodies as well as organic bodies, and that, in the second place, the organic are far more modifiable by them than the inorganic. But to avoid undue suspension of the argument, I content myself with saying that when the respective effects of gravitation, heat, light, &c., are studied, as well as the respective effects, physical and chemical, of the matters forming the media, water and air, it will be found that while more or less operative on all bodies, each modifies organic bodies to an extent immensely greater than the extent to which it modifies inorganic bodies.

Here, not discriminating among the special effects which these various forces and matters in the environment produce on both classes of bodies, let us consider their combined effects, and ask—What is the most general trait of such effects ?

* It is true that while not deliberately admitted by Mr. Darwin, these effects are not denied by him. In his *Animals and Plants under Domestication* (vol. ii, 281), he refers to certain chapters in the *Principles of Biology*, in which I have discussed this general inter-action of the medium and the organism, and ascribed certain most general traits to it. But though, by his expressions, he implies a sympathetic attention to the argument, he does not in such way adopt the conclusion as to assign to this factor any share in the genesis of organic structures—much less that large share which I believe it has had. I did not myself at that time, nor indeed until quite recently, see how extensive and profound have been the influences on organization which, as we shall presently see, are traceable to the early results of this fundamental relation between organism and medium. I may add that it is in an essay on "Transcendental Physiology," first published in 1857, that the line of thought here followed out in it wider bearings, was first entered upon.

Obviously the most general trait is the greater amount of change wrought on the outer surface than in the inner mass. In so far as the matters of which the medium is composed come into play, the unavoidable implication is that they act more on the parts directly exposed to them than on the parts sheltered from them. And in so far as the forces pervading the medium come into play, it is manifest that, excluding gravity, which affects outer and inner parts indiscriminately, the outer parts have to bear far larger shares of their actions. If it is a question of heat, then the exterior must lose it or gain it faster than the interior; and in a medium which is now warmer and now colder, the two must habitually differ in temperature to some extent—at least where the size is considerable. If it is a question of light, then in all but absolutely transparent masses, the outer parts must undergo more of any change producible by it than the inner parts—supposing other things equal; by which I mean, supposing the case is not complicated by any such convexities of the outer surface as produce internal concentrations of rays. Hence then, speaking generally, the necessity is that the primary and almost universal effect of the converse between the body and its medium, is to differentiate its outside from its inside. I say almost universal, because where the body is both mechanically and chemically stable, like, for instance, a quartz crystal, the medium may fail to work either inner or outer change.

Of illustrations among inorganic bodies, a convenient one is supplied by an old cannon-ball that has been long lying exposed. A coating of rust, formed of flakes within flakes, incloses it; and this thickens year by year, until, perhaps, it reaches a stage at which its exterior loses as much by rain and wind as its interior gains by further oxidation of the iron. Most mineral masses—pebbles, boulders, rocks—if they show any effect of the environment at all, show it only by that disintegration of surface which follows the freezing of absorbed water: an effect which, though mechanical rather than chemical, equally illustrates the general truth. Occasionally a "rocking-stone" is thus produced. There are formed successive layers relatively friable in texture, each of which, thickest at the most exposed parts, and being presently lost by weathering, leaves the contained mass in a shape more rounded than before; until, resting on its convex under-surface, it is easily moved. But of all instances perhaps the most remarkable is one to be seen on the west bank of the Nile at Philæ, where a ridge of granite 100 feet high, has had its outer parts reduced in course of time to a collection of boulder-shaped masses, varying from say a yard in diameter to eight or ten feet, each one of which shows in progress an exfoliation of successively-formed shells of decomposed granite: most of the masses having portions of such shells partially detached.

If, now, inorganic masses, relatively so stable in composition, thus have their outer parts differentiated from their inner parts, what must

we say of organic masses, characterized by such extreme chemical instability ?—instability so great that their essential material is named protein, to indicate the readiness with which it passes from one isomeric form to another. Clearly the necessary inference is that this effect of the medium must be wrought inevitably and promptly, wherever the relation of outer and inner has become settled : a qualification for which the need will be seen hereafter.

Beginning with the earliest and most minute kinds of living things, we necessarily encounter difficulties in getting direct evidence ; since, of the countless species now existing, all have been subject during millions upon millions of years to the evolutionary process, and have had their primary traits complicated and obscured by these endless secondary traits which the natural selection of favourable variations has produced. Among protophytes it needs but to think of the multitudinous varieties of diatoms and desmids, with their elaborately-constructed coverings ; or of the definite methods of growth and multiplication among such simple *Algæ* as the *Conjugatæ ;* to see that most of their distinctive characters are due to inherited constitutions, which have been slowly moulded by survival of the fittest to this or that mode of life. To disentangle such parts of their developmental changes as are due to the action of the medium, is therefore hardly possible. We can hope only to get a general conception of it by contemplating the totality of the facts.

The first cardinal fact is that all protophytes are cellular—all show us this contrast between outside and inside. Supposing the multitudinous specialities of the envelope in different orders and genera of protophytes to be set against one another, and mutually cancelled, there remains as a trait common to them—an envelope unlike that which it envelopes. The second cardinal fact is that this simple trait is the earliest trait displayed in germs, or spores, or other parts from which new individuals are to arise ; and that, consequently, this trait must be regarded as having been primordial. For it is an established truth of organic evolution that embryos show us, in general ways, the forms of remote ancestors ; and that the first changes undergone, indicate, more or less clearly, the first changes which took place in the series of forms through which the existing form has been reached. Describing, in successive groups of plants, the early transformations of these primitive units, Sachs * says of the lowest *Algæ* that "the conjugated protoplasmic body clothes itself with a cell-wall" (p. 10) ; that in "the spores of Mosses and Vascular Cryptogams" and in "the pollen of Phanerogams" . . . "the protoplasmic body of the mother-cell breaks up into four lumps, which quickly round themselves off and contract and become enveloped by a cell-membrane only after complete separation" (p. 13) ; that in the *Equisetaceæ* "the young spores,

* *Text-Book of Botany, &c.* by Julius Sachs. Translated by A. W. Bennett and W. T. T. Dyer.

when first separated, are still naked, but they soon become surrounded by a cell-membrane" (p. 14); and that in higher plants, as in the pollen of many Dicotyledons, "the contracting daughter-cells secrete cellulose even during their separation" (p. 14). Here, then, in whatever way we interpret it, the fact is that there quickly arises an outer layer different from the contained matter. But the most significant evidence is furnished by "the masses of protoplasm that escape into water from the injured sacs of *Vaucheria*, which often instantly become rounded into globular bodies," and of which the "hyaline protoplasm envelopes the whole as a skin" (p. 41) which "is denser than the inner and more watery substance" (p. 42). As in this case the protoplasm is but a fragment, and as it is removed from the influence of the parent-cell, this differentiating process can scarcely be regarded as anything more than the effect of physico-chemical actions: a conclusion which is supported by the statement of Sachs that "not only every vacuole in a solid protoplasmic body, but also every thread of protoplasm which penetrates the sap-cavity, and finally the inner side of the protoplasm-sac which encloses the sap-cavity, is also bounded by a skin" (p. 42). If then "every portion of a protoplasmic body immediately surrounds itself, when it becomes isolated, with such a skin," which is shown in all cases to arise at the surface of contact with sap or water, this primary differentiation of outer from inner must be ascribed to the direct action of the medium. Whether the coating thus initiated is secreted by the protoplasm, or whether, as seems more likely, it results from transformation of it, matters not to the argument. Either way the action of the medium causes its formation; and either way the many varied and complex differentiations which developed cell-walls display, must be considered as originating from those variations of this physically-generated covering which natural selection has taken advantage of.

The contained protoplasm of a vegetal cell, which has some self-mobility and when liberated sometimes performs amœba-like motions for a time, may be regarded as an imprisoned amœba; and when we pass from it to a free amœba, which is one of the simplest types of first animals, or *Protozoa*, we naturally meet with kindred phenomena. The general trait which here concerns us, is that while its plastic or semi-fluid sarcode goes on protruding, in irregular ways, now this and now that part of its periphery, and again withdrawing into its interior first one and then another of these temporary processes, perhaps with some small portion of food attached, there is but an indistinct differentiation of outer from inner (a fact shown by the frequent coalescence of pseudopodia in Rhizopods); but that when it eventually becomes quiescent, the surface becomes differentiated from the contents: the passing into an encysted state, doubtless in large measure due to inherited proclivity, being furthered, and having probably been once initiated, by the action of the medium. The connexion between con-

stancy of relative position among the parts of the sarcode, and the rise of a contrast between superficial and central parts, is perhaps best shown in the minutest and simplest *Infusoria*, the *Monadinæ*. The genus *Monas* is described by Kent as "plastic and unstable in form, possessing no distinct cuticular investment; . . . the food-substances incepted at all parts of the periphery" *; and the genus *Scytomonas* he says "differs from *Monas* only in its persistent shape and accompanying greater rigidity of the peripheral or ectoplasmic layer." † Describing generally such low and minute forms, some of which have neither nucleus nor vacuole, he remarks that in types somewhat higher "the outer or peripheral border of the protoplasmic mass, while not assuming the character of a distinct cell-wall or so-called cuticle, presents, as compared with the inner substance of that mass, a slightly more solid type of composition." ‡ And it is added that these forms having so slightly differentiated an exterior "while usually exhibiting a more or less characteristic normal outline, can revert at will to a pseud-amœboid and repent state." # Here, then, we have several indications of the truth that the permanent externality of a certain part of the substance, is followed by transformation of it into a coating unlike the substance it contains. Indefinite and structureless in the simplest of these forms, as instance again the *Gregarina*, ‖ the limiting membrane becomes, in higher *Infusoria*, definite and often complex; showing that the selection of favourable variations has had largely to do with its formation. In such types as the *Foraminifera*, which, almost structureless internally though they are, secrete calcareous shells, it is clear that the nature of this outer layer is determined by inherited constitution. But recognition of this consists with the belief that the action of the medium initiated the outer layer, specialized though it now is; and that even still, contact with the medium excites secretion of it.

FOOD ACCESSORIES AND DIGESTION.

By Dr. J. BURNEY YEO.

MAN, like any other animal, is so much the creature of his food—his physical perfection, his intellectual activity, and his moral tone are so dependent on the food he receives and the uses he is able to make of it in the processes of digestion and assimilation—that any accurate knowledge, founded on precise and reliable methods of investigation, of the influence on digestion and nutrition of dietetic habits must of necessity be of the most general interest.

* *A Manual of the Infusoria*, by W. Saville Kent. Vol. i, p. 232.
† *Ib.* Vol. i, p. 241. ‡ Kent. Vol. i, p. 56. # *Ib.*, l. c. Vol. i, p. 57.
‖ *The Elements of Comparative Anatomy*, by T. H. Huxley, pp. 7–9.

To Professor Sir William Roberts, of Manchester, we were already greatly indebted for a series of able and comprehensive researches on the action of "digestive ferments" and the "preparation and use of artificially digested food";* to those valuable researches Sir W. Roberts has recently added others equally important, chiefly on the subject of "food accessories" and their influence on the chemical acts of digestion. †

The results of these experimental inquiries are, in some respects, so novel and unexpected, and they contradict so many apparently unfounded assumptions, that they can not be too soon or too widely known.

Man, as Sir W. Roberts begins by pointing out, is a very complex feeder; he has departed, in the course of his civilization, very widely from the monotonous uniformity of diet observed in animals in the wild state. Not only does he differ from other animals in cooking his food, but he adds to his food a greater or less number of condiments for the purpose of increasing its flavor and attractiveness; but, above and beyond this, the complexity of his food-habits is greatly increased by the custom of partaking in considerable quantity of certain stimulants and restoratives, which have become essential to his social comfort if not to his physical well-being.

The chief of these are tea, coffee, cocoa, and the various kinds of alcoholic beverages.

It is to these "food accessories" and the elucidation of their influences on the processes of digestion that Sir W. Roberts's recent experiments and observations have been directed.

These "generalized food-customs of mankind," he remarks,

> are not to be viewed as random practices adopted to please the palate or gratify our idle or vicious appetite. These customs must be regarded as the outcome of profound instincts, which correspond to important wants of the human economy. They are the fruit of colossal experience, accumulated by countless millions of men through successive generations. They have the same weight and significance as other kindred facts of natural history, and are fitted to yield to observation and study lessons of the highest scientific and practical value.

It is unnecessary to describe here Sir W. Roberts's methods of investigation; they are fully set forth in the volume before us, and they are alike admirable for the ingenuity of their conception and the laborious accuracy of their prosecution.

His object was to ascertain the precise influence of these food accessories on the three chief parts of the digestive process: 1. *Salivary* digestion, i. e., the action of the saliva as a digestive agent; 2. *Peptic* digestion, i. e., the action of the fluids secreted by the stomach as di-

* "On the Digestive Ferments and the Preparation and Use of Artificially Digested Food." Lumleian Lectures, delivered before the Royal College of Physicians in 1880 by Sir William Roberts, M. D., F. R. S. London: Smith, Elder, & Co.

† "Lectures on Dietetics and Dyspepsia." Smith, Elder, & Co.

gestive agents; and, 3. *Pancreatic* digestion, i. e., the action of the secretion of the pancreas as a digestive agent.

We shall deviate a little from Sir W. Roberts's methed of marshaling his conclusions, and shall summarize his results as to the action of the various food accessories on these three acts of digestion continuously.

First, with respect to the action of ardent spirits on digestion. The experiments were made with "proof-spirit" and with brandy, Scotch whisky, and gin; and the conclusion is that, so far as *salivary* digestion is concerned, these spirits, when used in moderation and well diluted, as they usually are when employed dietetically, rather promote than retard this part of the digestive process, and this they do by causing an increased flow of saliva. "A teaspoonful of brandy or whisky introduced into the mouth can be perceived at once to cause a gush of saliva. The common practice of adding a tablespoonful of brandy to a basin of arrowroot or sago gruel, therefore, promotes its digestion."

The proportion must not, however, much exceed five per cent, and gin seems to be a preferable addition to either brandy or whisky. It was noticed in these experiments that brandy and Scotch whisky interfered with the digestive process, "precipitated the starch more readily," altogether out of proportion to the amount of alcohol they contained, and brandy was worse than whisky; and this circumstance appears to be due to certain ethers and volatile oils in them; and brandy contains a trace of tannin, which has an intensely retarding influence on salivary digestion.

With regard to "peptic" digestion the results are still more surprising. It was found that with ten per cent and under of proof-spirit there was no appreciable retardation, and only a slight retardation with twenty per cent; but with large percentages it was very different, and with fifty per cent the digestive ferment was almost paralyzed.

In the proportions in which these spirits are usually employed dietetically not only do they not appreciably retard digestion, but these experiments show that they "act as pure stimulants to gastric digestion, causing an increased flow of gastric juice and stimulating the muscular contractions of the stomach, and so accelerating the speed of the digestive process in the stomach." For obvious reasons (stated in these lectures) alcoholic drinks as used dietetically can never interfere with pancreatic digestion.

Passing from the consideration of the influence of these ardent spirits on digestion to the more complex problem of the influence of such alcoholic beverages as the various wines and malt liquors, Sir W. Roberts arrives at the following conclusions:

Even very small quantities of the stronger and lighter wines—sherry, hock, claret, and port—exercise a powerful retarding influence

on salivary digestion. This is wholly due to the acid—not the alcohol—they contain, and if this acid be neutralized, as it often is in practice, by mixing with the wine some effervescent alkaline water, this disturbing effect on salivary digestion is completely removed.

The influence of acids in retarding or arresting salivary digestion is further of importance in the dietetic use of pickles, vinegar, salads, and acid fruits.

In the case of vinegar it was found that 1 part in 5,000 sensibly retarded this process, a proportion of 1 in 1,000 rendered it very slow, and 1 in 500 arrested it completely; so that when acid salads are taken together with bread the effect of the acid is to prevent any salivary digestion of the bread, a matter of little moment to a person with a vigorous digestion, but to a feeble dyspeptic one of some importance.

There is a very wide-spread belief that drinking vinegar is an efficacious means of avoiding getting fat, and this popular belief would appear from these experimental observations to be well-founded. If the vinegar be taken at the same time as farinaceous food, it will greatly interfere with its digestion and assimilation.

As to malt liquors, provided they are sound and free from acidity, they interfere but litttle with salivary digestion; if they are acid, it is otherwise.

Effervescent table-waters, if they consist simply of pure water charged with carbonic acid, exercise a considerable retarding influence on salivary digestion; but if they also contain alkaline carbonates, as most of the table-waters of commerce do, the presence of the alkali quite removes this retarding effect.

"The use of these waters as an addition to wines is," Sir William Roberts observes, "highly commendable," as they "greatly mitigate or wholly obviate the retarding influence of these wines on the digestion of starch."

It was also observed that these weaker forms of alcoholic drinks (wines and beer) differed greatly in their influence on peptic digestion to that of the distilled spirits. They retarded it altogether out of proportion to the quantity of alcohol they contained. Port and sherry exercised a great retarding effect. "Even in the proportion of twenty per cent sherry trebled the time in which digestion was completed." It should further be borne in mind that this wine also greatly retards salivary digestion. Sherry, then, is not a suitable wine for persons of feeble digestive powers.

With hock, claret, and champagne it was also ascertained that their retarding effect on digestion was out of proportion to the alcohol contained in them; but champagne was found to have "a markedly less retarding effect than hock and claret"; indeed, in the proportion of ten per cent champagne had a distinct, though slight, accelerating

effect, and this superiority of champagne appears to be due to the "mechanical effects of its effervescent qualities."

The quantity of claret and hock often consumed by many persons at meals must exercise a considerable retarding effect on peptic digestion; but *small* quantities of these wines (and even of sherry) do not produce any appreciable retarding effect, but act as pure stimulants. These wines, then, may be taken with advantage, even by persons of feeble digestion, in small quantities, but not in large.

With regard to malt liquors, it was observed, as with wines, that they retarded peptic digestion in a degree altogether out of proportion to the amount of alcohol contained in them, and when taken in large quantities they must greatly retard the digestion, especially of farinaceous food; but a moderate quantity of light beer, when "well up," is favorable to stomach digestion.

It was proved by these experiments that the sparkling wines impede digestion less than the still ones, and when taken in moderate quantity "act not only as stimulants to the secretion of gastric juice and to the muscular activity of the viscus, but may, at the same time, slightly accelerate the speed of the chemical process in the stomach."

Next as to the influence of tea, coffee, and cocoa on the digestive processes:

Tea exerts a powerful retarding influence on salivary digestion, coffee and cocoa a comparatively feeble one.

Sir W. Roberts estimates the medium strength of the tea usually drunk at four to five per cent; strong tea may contain as much as seven per cent, weak tea as little as two per cent. Medium coffee has a strength of about seven per cent, and strong coffee twelve to fifteen per cent; cocoa, on the other hand, is generally weaker, not more than about two per cent, and this, he thinks, may be one reason why it is more suitable to persons with feeble digestions than tea or coffee.

Tea exercises a powerful inhibitory effect on salivary digestion, and this appears to be entirely due to the large quantity of tannin it contains.

It appears that tannin exists in two conditions in the tea-leaf. One, the larger portion, is in the free state, and is easily extracted by hot water; but about one fourth is fixed and remains undissolved in the fully exhausted tea-leaves. *Some persons have supposed that by infusing tea for a very short time—only two or three minutes—the passing of tannin into the infusion would be avoided. This is a delusion;* you can no more have tea without tannin than you can have wine without alcohol. Tannin, in the free state, is one of the most soluble substances known. If you pour hot water on a little heap of tannin it dissolves like so much pounded sugar. Tea infused for two minutes was not found sensibly inferior in its retarding power on salivary digestion to tea infused for thirty minutes.

One gentleman of my acquaintance (says Sir W. Roberts) in his horror of tannin was in the habit of preparing his tea by placing the dry leaves on a paper

filter and simply pouring on the boiling water. In this way he thought to evade the presence of tannin in his tea. But if you try the experiment, and allow the product, as it runs through the filter, to fall into a solution of perchloride of iron, you will find that an intense inky-black coloration is produced, showing that tannin has come through in abundance.

In order to diminish as far as possible the retarding influence of tea on salivary digestion, it should be made weak and used sparingly, and it should *not* be taken *with* but *after* the meal.

There is another means, mentioned by Sir W. Roberts, of obviating the retarding effect of tea on salivary digestion, and commended by him to the dyspeptic: *it is to add a pinch of bicarbonate of soda* to the tea when it is being infused in the tea-pot. He found that ten grains of soda added to an ounce of dry tea almost entirely removed this retarding influence. The infusion thus made is darker than usual, but the flavor is not sensibly altered, nor is the infusion rendered alkaline, for tea infusion is naturally slightly acid, and the soda, in the proportion mentioned, only just neutralizes this acidity.

Coffee, unless taken in very large quantity, has very little retarding effect on salivary digestion; this is explained by the fact that the tannin of tea is replaced in coffee by a substance called caffeo-tannic acid. Cocoa resembles coffee, and has little or no effect on salivary digestion; the use of coffee or cocoa is therefore preferable to that of tea for persons of feeble digestion.

With respect to the influence of tea and coffee on stomach digestion, it was found that they both exercised a remarkable retarding effect. There was no appreciable difference in the two beverages if they were of equal strength; but, as coffee is usually made of greater percentage strength than tea, its effect must ordinarily be greater. Cocoa also had much the same effect if used of the same strength as tea or coffee, but, when of the strength ordinarily employed, its effect was inconsiderable. Strong coffee—*café noir*—had a very powerful retarding effect, and persons of weak digestion should avoid the customary cup of "black coffee" after dinner.

"I could not detect," says Sir W. Roberts, "any appreciable difference between the effect of tea infused for two or three minutes and tea infused for fifteen or thirty minutes. If you wish to minimize the retarding effects of tea in persons of weak digestion, you should give instructions that the beverage be made weak, or that it be used in sparing quantities." And he adds in a footnote: "A good deal has been said of the injurious effects on gastric digestion of tannin contained in tea. I question whether the statements made with reference to this matter are worthy of attention. It has been alleged that meat-fiber is hardened by tea, and that the coats of the stomach are liable to be injured by this beverage. These views are entirely theoretical" (p. 48).

Perhaps one of the most unexpected results of these experiments of Sir W. Roberts was the discovery that *beef-tea* had a powerful retarding effect on peptic digestion, as much so as that of a five per

cent infusion of tea. Further researches appeared to show that this retarding effect of beef-tea was due to the salts of the organic acids contained in it.

While on the subject of beef-tea, it will be novel and instructive to many to hear that

there is a wide-spread misapprehension among the public in regard to the nutritive value of beef-tea. The notion prevails that the nourishing qualities of the meat pass into the decoction, and that the dry, hard remnant of meat-fiber which remains undissolved is exhausted of its nutritive properties; and this latter is often thrown away as useless. A deplorable amount of waste arises from the prevalence of this erroneous notion. The proteid matter of meat is quite insoluble in boiling water, or in water heated above 160° Fahr. The ingredients that pass into solution are the sapid extractives and salines of the meat, and nothing more except some trifling amount of gelatine. The meat remnant, on the other hand, contains the real nutriment of the meat, and if this be beaten to a paste with a spoon or pounded in a mortar and duly flavored with salt and other condiments, it constitutes not only a highly nourishing and agreeable but also an exceedingly digestible form of food.*

Beef-tea must therefore be looked upon rather as a stimulant and restorative than as a nutrient beverage, but it is nevertheless very valuable on account of those properties.

Sir W. Roberts puts forward an ingenious argument, which can not be fully repeated here, in favor of the view that, in healthy and strong persons, this *retarding* effect on digestion observed to be produced by many of the most commonly consumed food accessories answers a distinctly useful end. They serve, he maintains, the purpose of wholesomely slowing the otherwise too rapid digestion and absorption of copious meals.

A too rapid digestion and absorption of food may be compared to feeding a fire with straw instead of with slower-burning coal. In the former case it would be necessary to feed often and often, and the process would be wasteful of the fuel; for the short-lived blaze would carry most of the heat up the chimney. To burn fuel economically, and to utilize the heat to the utmost, the fire must be damped down, so as to insure slow as well as complete combustion. So with human digestion: our highly prepared and highly cooked food requires, in the healthy and vigorous, that the digestive fires should be damped down, in order to insure the economical use of food. . . . We render food by preparation as capable as possible of being completely exhausted of its nutrient properties; and, on the other hand, to prevent this nutrient matter from being wastefully hurried through the body, we make use of agents which abate the speed of digestion.

It must be borne in mind that these remarks apply only to those who possess a healthy and active digestion. To the feeble and dyspeptic any food accessory which adds to the labor and prolongs the time of digestion must be prejudicial; and it is a matter of com-

* "These remarks on beef-tea apply equally to Liebig's extract of meat, Brand's essence of beef, and Valentine's meat-juice, all of which are devoid of albuminous constituents" ("British Medical Journal," August, 1885).

mon experience that beverages which in quantity retard digestion have to be avoided altogether by such persons or partaken of very sparingly.

In the dietetic use of wines the writer of this article has constantly had occasion to make the observation that those wines agree best and are most useful which are absorbed and eliminated from the system *with the greatest rapidity*, as tested by the increase of the renal secretions, and he has been led to the practical conclusion that this is the best criterion of the suitability of any particular wine to any particular constitution. If the effect of different wines on notoriously gouty persons be carefully observed, it will be found that some can drink champagne (in moderation, of course) with impunity, especially if a small quantity of an effervescing alkaline water be added to it, while claret will at once provoke some manifestations of gout; others, who are unable to drink champagne without provoking a gouty paroxysm, will often be able to drink a mature, fine, soft claret even with advantage; others will support hock well, and a few can drink fine sherries and ports in small quantities; but in all it will be found that the test of the suitability of the particular wine to the particular constitution is its susceptibility to rapid elimination and *vice versa*.

It has occurred also to the writer to make many observations as to the circumstances under which tea and coffee are found to agree or disagree with different persons; in the first place, as Sir W. Roberts has pointed out, tea, if taken *at the same time* as farinaceous food, is much more likely to retard its digestion and cause dyspepsia than if taken a little time after eating; and the custom adopted by many persons at breakfast, for instance, of eating first and drinking their tea or coffee afterward is a sensible one; so also it is better to take one's five-o'clock tea without the customary bread-and-butter or cake than with it.

Indeed, while there is little that can be said against a cup of hot tea as a stimulant and restorative, when taken about midway between lunch and dinner, and *without* solid food, it may, on the other hand, be a fruitful cause of dyspepsia when accompanied at that time *with* solid food. It is also a curious fact that many persons with whom tea, under ordinary circumstances, will agree exceedingly well, will become the subjects of a tea dyspepsia if they drink this beverage at a time when they may be suffering from mental worry or emotional disturbance.

Moreover, it is a well-recognized fact that persons who are prone to nervous excitement of the circulation and palpitations of the heart have these symptoms greatly aggravated if they persist in the use of tea or coffee as a beverage. The excessive consumption of tea among the women of the poorer classes is the cause of much of the so-called "heart-complaints" among them: the food of those poor women consists largely of starchy substances (bread-and-butter chiefly), to-

gether with tea, i. e., a food accessory which is one of the greatest of all retarders of the digestion of starchy food.

The effect of coffee as a retarder of stomach digestion would probably be more felt than it is were it not so constantly the practice to take it only in small quantity after a very large meal; it is then mixed with an immense bulk of food, and its relative percentage proportion rendered insignificant; and to the strong and vigorous the slightly retarding effect on digestion it would then have may be, as Sir W. Roberts suggests, not altogether a disadvantage; but after a spare meal and in persons of feeble digestive power the cup of black coffee would probably exercise a retarding effect on digestion which might prove harmful. It is also worthy of remark that in the great coffee-drinking countries this beverage is made not nearly so strong as with us. In this country *good* coffee always means *strong*, often very strong coffee; but on the Continent they possess the faculty of making *good* coffee which is not necessarily very *strong* coffee, and which is, therefore, as a beverage, less likely to do harm.

The general conclusion to be drawn from these highly interesting and instructive researches is that most of the "food accessories" which in the course of civilization man has added to his diet are, when taken in moderation, beneficial to him, and conduce to his physical welfare and material happiness; but if taken in excess they may interfere to a serious and harmful degree with the processes of digestion and assimilation. It is also made clear that dietetic habits which may prove agreeable and useful to those who enjoy vigorous health and a strong digestion need to be greatly modified in the case of those who are feeble and dyspeptic.—*Nineteenth Century.*

PHOTOGRAPHING THE HEAVENS.

BY DR. HERMANN Y. KLEIN.

UNDOUBTEDLY one of the greatest achievements of modern days is the introduction of the exceedingly sensitive dry-plate in photography. By it one is enabled to picture the lightning's flash, the trotting horse, the surging wave, and the foliage swayed by the breeze. It is not to be foreseen what manifold applications this new method will eventually find in the natural sciences. Here we will consider only *one* of its numerous applications, namely, its use in photographing the starlit heavens.

Whoever has tried to form an idea of the number of stars, visible to the naked eye on a clear winter's night, almost invariably overestimates them. The layman declares he sees a hundred thousand, ay, a million stars. Such estimates, however, far exceed the truth, and, if anything is certain, it is the fact that the number of stars to be seen

with the naked eye is very small. All stars discernible by the keenest of human sight, without the aid of a telescope, have long been noted down on charts, and their position in the vaulted dome exactly determined.

Should one count up all the stars in those parts of the heavens that become visible to us in the course of a year, even this sum would not by far approach seven thousand. However, if one resorts to a telescope, matters grow to be quite different; more and more stars then become visible, the number depending on the strength of the instrument in use. Fig. 1 represents a certain portion of the heavens as seen by the unaided eye. One discerns two brighter stars and several smaller ones. Fig. 2 shows this same spot, but as seen through a powerful telescope. This picture has not merely been drawn from fancy. Each point, even the smallest, was, after close observation, entered with the utmost care on a large chart, of which this illustration

Fig. 1.

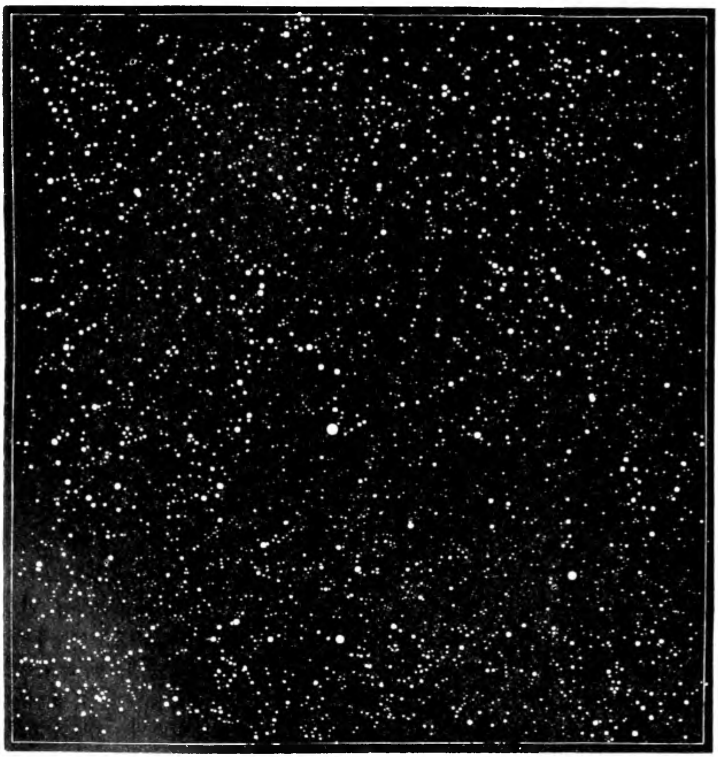

Fig. 2.

is a copy, but reduced in size. And each single one of these stars is a mighty body, in its sphere a shining sun, equaling ours in grandeur and splendor. From the beginning, each of these suns has traveled its prescribed round, and has filled its place in the vast universe. Such charts of the stars are leaves from the great volume of

the history of the universe, a work which astronomy teaches us to read. On one of these pages, that has already been in part deciphered, is recorded the destiny of our planet.

It is, then, not surprising that astronomers seek to gain possession of as many reliable copies of such leaves from this history as possible; in other words, seek to own as exact and extensive star-maps as will include the very smallest luminous points in the heavens. What untold work the compiling of such charts entails may well be imagined; indeed, this is a task which is almost beyond human power. The chart from which the above picture is a copy was compiled at the observatory at Paris, and work at the same has already been continued for many decades. For years past, the two brothers, Paul and Prosper Henry, have been engaged in this exacting undertaking; but, notwithstanding the great experience which they in the course of time had gathered, their task almost came to a sudden end in the year 1884. At that time, while pursuing their observations, they came to that region of the heavens traversed by the milky-way. As is well known, the mild, lambent light of the milky-way is caused by a conglomeration of countless millions of stars placed behind one another to endless depths. To reproduce these millions of stars on charts proved to be utterly impossible.

The two observers then summoned the art of photography, recently so much improved, to their aid. Naturally they could not make use of the ordinary apparatus of the photographer; indeed, they were obliged to build a special telescope for their purpose. By means of clock-work, they succeeded in imparting to this a movement so prescribed and so regulated that the stars, though continuing in their unbroken course in the heavens, yet retain a stationary position with reference to the photographic plate. After many painstaking experiments, the enterprise was successful beyond expectation. Even the faintest of stars were plainly discernible on the plate, and in this manner more was accomplished in one hour than could be done by the old method of inscribing each star in many months.

These results incited to further progress. A new and very large telescope was constructed and directed toward the starry heavens. The plate now showed stars of the fifteenth magnitude, i. e., those whose light is *so* faint that only very few telescopes in all Europe can render them perceptible. In order to obtain this result, the plate, notwithstanding its extreme sensitiveness, had to be exposed to the light of these stars for fully an hour. If one were to carefully examine such a plate, or rather a *cliché* made therefrom, doubts might perhaps arise as to whether some of the little points thereon might not have been occasioned by particles accidentally present on the original plate. Such doubts might well be entertained, but Messrs. Henry have succeeded in meeting them in a most ingenious manner. After having exposed the plate for an hour, they shifted its position a trace to the right, and

again exposed it for the same length of time. After this they lowered the plate with the telescope to the same extent as they had before shifted its position, and then, for a third time, exposed for an hour. If, after this, the original were to be examined with a microscope, it would be seen that each little star is really composed of three points, which form a small triangle. Thus any doubt is dispelled that might have been entertained as to whether an accidental blur had been pictured.

The advantage in preparing representations of the heavens by means of photography rests not only on the fact that by this means charts of the stars can be obtained much more readily than was the case when each star had to be separately noted, but the pictures thus obtained also seem to be absolutely correct; they contain no faulty entries, no mistakes. Even the most attentive observer is liable to error; he may overlook one or more stars, he may make a wrong entry, etc. All of these risks are not to be feared in employing a photographic plate; it is like a retina that sees everything *as it is!* This advantage can not be sufficiently appreciated, for it enables us to leave to coming generations an absolutely true and entirely correct picture of the starry heavens of to-day. The director of the observatory at Paris has for this reason suggested the obtaining of a complete photographic picture of the entire heavens by the systematic co-operation of different observatories in the northern and southern hemispheres. This is, indeed, a grand project; and to see it realized would, at all events, require a period of from eight to ten years—but what exceedingly important results would ensue from this!

With such charts from different times at his disposal, and equipped with a microscope and a micrometric apparatus to carry out his measurements, the investigator of the future will be enabled to make in his study astronomical discoveries that have hitherto escaped direct observation by the telescopes of the observatory. In his study he will be able to prove whether any, and, if so, which stars have changed their position in the heavens, whether among the countless number of the faintest little stars in the milky-way new ones have arisen, or old ones disappeared—in short, with the aid of such charts there opens to the mind a vista of research and discovery that seems well-nigh endless.

How much may be escaping astronomical science of to-day, simply because the eye of mortal explorer chances not to alight on that very point in the depths of the heavens where just then a most important event is taking place!

In future this will be different. Photographed charts of the heavens give an exact likeness of the appearance of the celestial dome at the time of their taking, and these may be examined and studied at any place and at any time, by day and by night. The most remote planet that revolves around the sun, known of to-day, is Neptune; yet it seems most probable that beyond this, one or even more plan-

ets are existing. As, however, they move but very slowly, and at the same time emit but little light, it has not yet been possible to discern them among the millions of little fixed stars. But, when once the entire heavens, even to the very smallest of visible stars, shall have been photographed, and if this work be repeated after a period of about ten years, the charts thus obtained will solve the problem as to the most remote planets, and the latter must be found. Ay—even more. The photographic plate is superior to the observant eye, in perceiving and reproducing the smallest stars, inasmuch as it shows objects in those places in the heavens where, with the most powerful telescopes, nothing more is to be seen.

In this connection the brothers Henry have recently made a most singular discovery. On the 16th of November they directed their large photographic telescope to that spot in the heavens where the star Maja is in the Pleiades, and afterward found on their plate, besides numerous stars, a spiral, nebulous spot, which, to a certain extent, seemed to come from the star Maja. As, even with the greatest telescopes of the observatory at Paris, no signs of such vapor could be perceived in that particular part of the heavens, a new photograph was taken on the 8th of December; this also showed the vapor, and a third picture, obtained the following day, once more bespoke its presence.

There can, then, be no doubt as to the existence of a spiral-like nebulous spot in the vicinity of that star, but of which the eye, even with the aid of a most powerful telescope, can perceive naught. What wonderful prospects for the future here open to view! A veritable astronomy of the invisible begins. Celestial orbs, ever veiled from our direct gaze, are rendered perceptible—ay, trace their own picture. Therein lies the highest triumph of the human mind, that it is able, in the true sense of the word, to *force* Nature to reveal her secrets; that a ray of light, called into being in the most remote depths of space, created at a time ere perhaps the foot of man had ever trodden the earth, should to-day itself trace on a plate the outline and the form of that orb from which it emanated myriads of years ago.—*Translated for the Popular Science Monthly from Die Gartenlaube.*

HOW ALCOHOLIC LIQUORS ARE MADE.

By JOSEPH DAWSON.

WHATEVER may be our individual views or prejudices in relation to the use and abuse of alcoholic liquors, the process of their manufacture is a very interesting chemical operation. Proof-spirit is defined by the United States internal revenue laws to be that mixture of alcohol and water which contains one half of its volume of

absolute alcohol and 53·71 parts of water. When the alcohol and water are mixed together—while combining—contraction in volume takes place to the extent of 3·71 parts, resulting in 100 parts of proof-spirit. The law declares that the duties on all spirits shall be levied according to their equivalent in proof-spirits. The hydrometers adopted by the Government for the purpose of testing the degree of strength are graded and marked (0°) for water, (100°) for proof-spirit, and (200°) for absolute alcohol, at a standard temperature of 60° Fahr.

Alcoholic liquors can be made from any substance that contains saccharine matter already formed by Nature, or from any substance that contains the constituent elements that can be converted by some artificial process into the saccharine principle. In the United States they are generally produced from corn, rye, wheat, barley, rice, molasses, apples, grapes, and peaches; sometimes from potatoes and beets. Vinous fermentation converts sugar, glucose, or saccharine matter into alcohol and carbonic-acid gas; the latter passing off into the atmosphere.

In order to bring about vinous or alcoholic fermentation five agents are indispensable, viz., saccharine matter, water, heat, a ferment, and atmospheric air. Sugar or saccharine matter in its various forms is the only element from which alcohol can be produced; the others are mere auxiliaries to the decomposition.

By establishing the quantity in volumes of the elements of sugar and alcohol, as indicated by the following tabulated statements, and by comparing the constituent elements of the two articles, so dissimilar in appearance, the fact of their slight difference would be incredible were it not established by science:

COMPOSITION OF SUGAR IN VOLUMES.		COMPOSITION OF ALCOHOL IN VOLUMES.	
Vapor of carbon	3	Vapor of carbon	2
Hydrogen	3	Hydrogen	3
Oxygen	1½	Oxygen	0½

GAY-LUSSAC.

Take one volume of vapor of carbon and one of oxygen from sugar, which is accomplished by vinous fermentation and distillation, and you have alcohol.

In order to obtain the best results, the process of scalding the various kinds of grain used and making the yeast requires very skillful management; so much so that the largest distillers employ a professional and practical chemist to look after the scientific part of the business. The quantity and power of the yeast, in proportion to the quantity of saccharine matter in the mash, must be properly balanced, or in one case the fermentation will be too rapid, developing excessive heat, and consequently a loss of alcoholic vapor passing off with the carbonic-acid gas, also inducing acetic fermentation, which, under certain conditions, is a destroyer of alcohol; or, in the other case, if the yeast is too weak, so that it will not convert all the saccharine matter into

alcohol, there will be a waste of material, and consequently a pecuniary loss to the manufacturer.

Can pure unadulterated alcoholic liquors be now obtained? This is a question frequently asked with a doubtful accent. I answer yes, as pure as were ever made, which assertion I will substantiate by giving a description of their manufacture. And as whisky is one of the most common liquors, it may be taken as an example. Malt is an almost indispensable article in connection with whisky-distilling, and is usually made of rye or barley. The grain is soaked in water until it begins to swell; it is then placed in a pile on the malting-floor, where it remains until heat is generated and saccharine fermentation takes place, causing the grain to germinate or sprout, and developing the saccharine matter and a peculiar ferment called diastase, which is the main object in the process of malting. When the process of germination has arrived at the point desired, the grain is spread over the floor to dry, for the purpose of suspending further fermentation; when dry, the grain is very sweet and brittle, easily ground, and is known to commerce as rye and barley malt.

The best distillers are very particular about the quality of grain they use, buying only the best in market. The proportions of each kind of grain used vary according to the particular brand of whisky desired. The usual proportions of grain are, two thirds corn and one third rye and malt. The corn is ground into a fine granulated meal, the rye to a medium fineness, and the malt is coarsely ground. The meal is all weighed, scalded, and mashed under the supervision of the United States internal revenue storekeeper. The corn-meal, being more difficult to scald than rye and malt, is first put into a mash-tub containing a proper quantity of hot water, and while the mash is being vigorously stirred with a revolving rake driven by steam or water-power, the temperature is raised to about 170° Fahr. This operation scalds the corn-meal and develops the starch; after remaining at this temperature for the proper length of time, cold water is added to reduce the temperature to about 150° Fahr., the rye and malt are then added, and the whole mass is continually stirred until the scalding is complete, and the starch is developed and converted into dextrine, and then into saccharine matter by the potency of the diastase contained in the malt. It is then cooled down as quickly as possible, in order to avoid viscous fermentation, by the addition of cold water and ice, to about 80° Fahr., and drawn off into a fermenting vat, and the yeast which has been previously prepared is added.

The fermenting period varies from forty-eight to seventy-two hours, according to the kind of yeast used. By testing the density and temperature of the mash at the time of setting, and on the completion of fermentation, with the aid of a saccharometer and thermometer, a close approximation can be obtained of the quantity of proof-spirit contained in the beer—by which name the mash is called after

fermentation; the greater the attenuation of the beer, as shown by the saccharometer, the greater the quantity of spirit.

Fermentation being completed, where the ordinary copper stills are used, the beer is run into one still and is boiled; the alcohol in the beer, being more volatile than water, rises, combined with more or less water, and passes through a copper coil or worm submerged in a cistern of water into which a continuous stream of cold water is running; at the top of this cistern is an overflow-pipe conveying the heated water off as it rises. This operation condenses the vapor in the worm, and the spirit flows out colorless; as all spirits, whether made from grain, fruit, or vegetables, flowing from the still-worm, have the appearance of water.

The product of this first distillation is called low-wine, from the fact that it is not of sufficient strength and purity to put upon the market. The boiling is continued until all the alcohol in the beer is evaporated and condensed; then the refuse is drawn off from the still and fed to cattle and hogs. The low-wine is then run into still No. 2, called the doubler, and boiled again. The product from the doubler will be whisky varying from 100° to 150° in strength.

When the three-chambered wooden still or column is used, and the beer is boiled by steam, spirits are produced of marketable strength at each run of the still.

Under the internal revenue laws the distillers of grain and molasses can have no access to the spirits during the process of their manufacture, as the spirits are conveyed from the still in continuously closed pipes to large cisterns in a room with only one entrance, upon which is a Government lock, of the key of which the United States gauger is the custodian, until the spirits have been drawn off into barrels, and he has gauged the quantity and tested their degree of strength by the aid of a hydrometer and thermometer, placed a warehouse stamp on each package, and marked on each the capacity, quantity, and degree of strength of the contents.

The gauger is, fortunately, not required to taste of the spirits to test their quality, as quality is not taken into consideration in levying the tax. After the gauger has completed his duties, the United States storekeeper takes charge of the spirits and sees that all of the packages are safely deposited in the distillery bonded warehouse, where they remain under a Government lock—the key of which is in the care of the storekeeper—until the tax is paid.

The limit of time that spirits can remain in bond, by the present revenue law, is three years. Congress was petitioned at the last two sessions, by parties interested in distilling, for an extension of the bonded period, but the petition was, I think, unwisely denied.

It would be a blessing to the whole country if Congress would pass a law embodying the substance of the three following items: 1. Granting unlimited time for spirits to remain in bond, in order to give all

the time for improving the spirits desired before payment of the tax. 2. Prohibiting the withdrawal of alcoholic liquors from bond until they have been in the warehouse at least twelve months; for the reason that new spirits, although they may be pure, are not fit for internal use, and should not be placed upon the market for sale until their constituent elements are thoroughly combined by age. 3. Prohibiting (if it can be done constitutionally) the mixing or compounding different kinds of alcoholic liquors, particularly those made from grain with those made from fruit, or the adulteration of the same by the addition of any deleterious or injurious substances. Heavy penalties to follow every violation and conviction.

Various contrivances have been adopted, both in this and foreign countries, for the purpose of producing a kind of artificial age, and various compounds have been used to accomplish the desired result, and to a certain extent have been successful in deceiving the novice or uninitiated; but, on the whole, you might as well try to put a mature brain, developed in all its manly proportions, upon the shoulders of a youth, as to try to make new spirits old, minus the element of time, and the necessary accompanying environments.

A company in Boston, Massachusetts, claim to purchase the oldest liquors they can find in distillery bonded warehouses (three years old), and to purify and increase their mellowness by forcing warm air through them, thereby oxidizing the fusel-oil (or heavier alcohols), and expelling into the open air the light, poisonous ethers, leaving the liquors free from the aldehydes which stupefy and destroy the brain-tissues. The air is first passed through a chemical solution (Professor Tyndall's well-known method), which deodorizes as well as destroys all germs of animal or vegetable origin; and after being thus treated, analysis shows it to be pure atmospheric air, 79 parts nitrogen, and 21 parts oxygen. This purified air is then heated to a certain temperature, and, with the aid of a pump, forced through pipes with almost infinitesimal perforations, so as to bring the greatest amount of surface of air in contact with the greatest amount of surface of liquor in the shortest space of time, warming the liquors and producing a violent agitation, which process, undoubtedly, accelerates the union and assimilation of the constituent elements, and, they also claim, eliminates the poisonous gases. The liquors are then filtered by the best-known methods to free them from any remaining *débris*.

But to return to the distillery: you will see that the processes which the grain has gone through of mashing, fermenting, and the extraction of the spirits from the beer by distillation, and the placing of the completed product in the distillery bonded warehouse, are all done under the supervision of a Government officer, and thus far the distiller has had no opportunity, even if he had any desire, to adulterate the liquor. Any distiller who wishes to establish a reputation for manufacturing a fine article, is as much interested in keeping his liquor

pure as any person is who wishes to purchase and properly use a pure article.

After the internal revenue tax has been paid, and the tax-paid stamps properly placed upon the packages, the spirits are withdrawn from bond; each package having two stamps upon it—a warehouse and a tax-paid stamp—and when put upon the market in this condition they are known as two-stamp goods; but the best distillers, instead of selling their goods directly from the bonded warehouse—if they have not been filtered and refined during the process of their manufacture—transfer them to the rectifying-house for rectification; the object of which is to remove any pernicious substances or impurities, such as the grosser properties of the essential oils, or fusel, and acetic acid, and to improve the quality and flavor of the spirits. It is the essential oils extracted from the various materials used that impart the peculiar distinguishing characteristics to each kind of liquor. The alcoholic property is virtually the same in all spirituous liquors.

The process of rectification is generally done by redistilling, and filtering through alternate layers of woolen blankets, sand, and granulated bone or maple charcoal—other complicated mechanical arrangements are sometimes used, called rectifiers, but they are not common—after which process, a little burned sugar is added to give them a kind of straw-color, simply, I presume, to distinguish them from water, and which gives the appearance of age without improving or injuring their quality. After rectification, the spirits are gauged by the United States gauger, and a rectifier's stamp is placed upon each package, and the whisky is then ready for the market, pure and unadulterated, and known as one-stamp goods. Remember that I am now stating how *good whisky* is made; all whisky is not made with the same degree of care. Some people are under the impression that if they buy two-stamp goods they are certainly getting a pure article, but that is not always the case, unless the whisky has been properly rectified during the process of manufacture.

There is a vast difference between rectification proper and mixing or compounding. Rectification, in its proper sense, is purifying and refining. Compounding is diabolizing. Moral: *Purchase from first hands, if possible.*

By this, I do not mean to insinuate that all dealers in liquor are unscrupulous; for, paradoxical as it may appear to some minds, there are many very generous, noble-hearted, upright men engaged in the liquor-traffic; but the demand for cheap liquor is so great that some men can not resist the temptation to mix or compound, in order to supply this demand, and some of them feel that they are compelled to do it against their will in order to hold their customers; and this practice will continue until the strong arm of a righteous law is placed upon it—a law that every honest distiller and liquor-dealer will cordially approve.

Therefore, if you want a pure article, purchase from a distiller or first-class, reliable dealer ; and, by the term *first class*, I do not mean the man who has the largest and most attractive place of business, and the most capital invested, but the man who is known for his integrity and truthfulness of character. Insist that the spirits must be at least twelve months old, and also be willing to pay a fair price for them. There is no more exception to the rule in the liquor business than in any other, that, if you want something of value, you must expect to pay value for it.

At some distilleries, the spirits pass through a process of filtering between the worm and cistern-room, which extracts the impure foreign matter that is unavoidably forced up from the still with the vapor of spirits. When this purifying process is skillfully and carefully done, there is no absolute necessity for the further manipulation or rectification of the spirits, and the only element then required to make the spirits fit for medicinal purposes is time, and the longer the time the better. If kept in wooden packages the spirits will improve and acquire a slight color by age. Coloring-matter is not allowed by the Government to be put in the spirits when this filtering process is done at the distillery.

Alcoholic liquors should not be offered for sale until they have been filtered or properly rectified, either during the process of manufacture, or after they have been withdrawn from the distillery bonded warehouse. The best distillers never let their goods go on the market until they have themselves put the whisky through a process of rectification, or refining ; and woe be to the man who dares to change its character in the original package bearing their brand, if they find sufficient evidence against him !

Rye-whisky is made from rye and malt, without corn, but experts say that it requires much longer time to mature, and become ripe and smooth, than does Bourbon whisky, which is made from corn, rye, and malt. Gin is made from the same materials and in the same manner as whisky, with one addition : juniper-berries are boiled in the last distillation, imparting their peculiar flavor.

There are two objections to straight (unmixed) American gin : First, it is usually sold when new, because the dealer can buy it cheaper and make a larger margin upon it than he can on the old article. Second, straight American gin is not filtered and relieved of foreign and impure matters, but is sold with them in, obnoxious as they are, depending upon the juniper flavor to conceal their presence.

Rum is made from molasses, diluted with water, and a ferment added ; after fermentation it is distilled in the same manner as whisky and gin.

Brandy is made from apples, grapes, peaches, and other fruits, generally from the expressed juice, but occasionally from the pomace or crushed fruit after fermentation. Fruits possess by nature an

azotized albuminous substance which produces spontaneous vinous fermentation, so that artificial yeasts or ferments are unnecessary. About fifty per cent more brandy can be made from ripe than from green fruit, and late fruit will produce much more brandy than early fruit. Brandy-distillers ought to devote more attention to filtration than they are in the habit of doing; it is a moral obligation which they owe to society.

Some people are so credulous that they believe all imported liquors are pure and perfectly straight. By paying a very high price, pure imported liquors can be obtained, but the superiority of the best article consists mainly in great age. Some imported liquors are mixed, compounded, and artificially flavored before shipment to this country, and are again mixed with so-called pure spirit after their arrival here. Trois-six French spirit, when originally produced, was the pure spirit of grape-wine; now it is mainly manufactured from potatoes and the cereals, and forms the basis of many of the liquors imported into this country under the brand of French brandies and wines, and sold to a credulous public as the product of the pure juice of the grape.

The duty on imported liquors is two dollars per proof-gallon, and on imported wines fifty cents per wine-gallon, while the United States internal revenue tax is only ninety cents per proof-gallon on domestic spirits, and none on domestic wines. People can judge for themselves whether the imported article is worth the difference in price.

Chemists, in their analysis of anhydrous, absolute, or pure alcohol (200°), do not exactly agree in their results. However, there is only a slight variation from the following statement in the proportions of the three constituent elements:

Carbon	52·32
Oxygen	34·38
Hydrogen	13·30
	100·00

Alcohol showing the foregoing analysis acts as a caustic on the living tissues of the body, and by injection into the veins it causes sudden death by coagulating the blood. By introduction into the stomach it generally causes death.

Commercial alcohol is principally made from Indian corn, and generally indicates twelve degrees less in strength, being 188°, than the preceding analysis. This commercial alcohol is reduced to any degree desired by the addition of water, and known to the trade as French, pure, cologne, or neutral spirits, while in fact it is nothing but dilute alcohol.

This spirit forms the bulk of nearly all the low-priced alcoholic liquors, whether called rum, gin, whisky, domestic or foreign brandies, that are placed upon the market, and this neutral corn-spirit enters largely into many of the better brands. Some wholesale liquor-deal-

ers and compounders state that liquors made from pure cologne or neutral spirits are the purest liquors that can be found. That may be true; also, sulphuric acid and aqua-fortis may and presumably are pure, but they are, nevertheless, dangerous and deadly poisons.

This neutral spirit has been robbed of all its native richness and reduced to a skeleton of extreme poverty by eliminating its natural oils and leaving it with a harsh, cutting, penetrating nature, and when taken internally it produces the worst effects upon the tissues. The natural oils in the materials from which alcoholic liquors are produced are the oils that have the greatest natural affinity for that particular kind of liquor, and if permitted to remain where they belong, when taken into the stomach in a refined condition, properly combined and assimilated, are bland and sedative in their effects, and any spirit that has been deprived of them is not fit to enter the human stomach.

THE CARE OF PICTURES AND PRINTS.

By PHILIP GILBERT HAMERTON.

AMONG the most curious *apparent* inconsistencies of human nature is the possibly complete independence of the productive and the conservative states of mind. It seems as if the talent for producing things often led, of itself, to a carelessness about their preservation, perhaps from a feeling that it is easy to replace what may happen to be deteriorated. The most conspicuous instance of this temper is that of Turner, among artists. He was the most productive of painters and the most accumulative, liking to keep his own works about him much more than painters generally do; and yet at the same time he does not appear to have given a thought to the preservation of the works he so greatly valued. His pictures were carelessly kept in a gallery that was never repaired; his drawings were never arranged till Mr. Ruskin arranged them six years after Turner's death, and it cost Mr. Ruskin a whole autumn and winter (1857), with the help of two assistants, working "every day, all day long, and often far into the night," to convert the Turnerian mess of confusion into order.

Had it been confusion or disorder simply, the evil would have been completely remediable by careful labor; but unfortunately the same carelessness that led to disorder involved carelessness about preservation. Many of the drawings were eaten away by damp and mildew, "and falling into dust at the edges, in capes and bays of fragile decay." Others were worm-eaten, some were mouse-eaten, "many torn half-way through." Turner's way of keeping his drawings was to roll them up in bundles and cram them into drawers. The rolled bundles do not even appear to have been protected by paper closed at the end against dust, and the squeezing seems to have flattened them;

for Mr. Ruskin tells us that "dust of thirty years' accumulation, black, dense, and sooty, lay in the rents of the crushed and crumpled edges of these flattened bundles." There were also numbers of pocket sketching-books "dropping to pieces at the back, tearing laterally whenever opened, and every drawing rubbing itself into the one opposite."

What strikes us most in this disorder is not so much the deterioration of the sketches and drawings, which Turner possibly may not have foreseen, as the intolerable inconvenience of a system that must have made reference so difficult for the artist himself as to be always tedious and often impossible. A collection of studies should always be so arranged that any study whatever, even down to the most trifling memorandum, may be found at a moment's notice. The care of an artist's collection of studies is not, however, the subject of the present paper, which is addressed rather to the lay possessors of works of art than to professional artists.

Turner's way of keeping his drawings is a model of everything that the collector ought to avoid. Nobody but an artist would think of keeping drawings rolled up in bundles, for the simple reason that you can never see a drawing properly unless it lies flat. Then we learn that Turner exposed his collection to every one of the enemies that a prudent keeper provides against. These enemies are damp, dust, and vermin. In the case of water-color and oil pictures there are two other foes, light and darkness, a water-color being liable to fade in the light, and an oil-picture to turn yellow for the want of it.

Damp and mildew are often spoken of as two enemies, but in fact they are only one, as mildew is a fungus or collection of fungi thriving only in damp situations.* Damp, as everybody knows, is retained moisture, or, in other words, water diffused in minute particles that are held by some other substance so as to be prevented from joining each other and flowing away, while they do not get access to the air so as to be carried off by evaporation. Some substances are extremely favorable to the retention of damp, and it so happens that the mill-board commonly employed by framers to put behind prints, and by book-binders who make portfolios, is one of those substances which absorb and retain damp with particular facility. It is employed by copper-plate printers to dry impressions, which are placed between sheets of mill-board under pressure, the boards soon drinking up the water contained in the wetted paper. The ingenuity of framers has led them to select this (of all substances in the world) to put behind engravings that are hung up on walls; and, when the walls happen to be damp, it follows as a matter of course that the engravings are spoiled by mildew or rust-spot. If the reader has ever lived in a

* So far as I know. My experience of mildew has been chiefly with prints and the sails of boats, which require almost as much care as prints, and in these cases mildew has always required damp as a condition of its existence.

house that is even moderately damp, he can hardly have failed to notice that the boards behind framed engravings swell and bulge out, which is the result of an increase in the bulk and area of the boards exactly proportionate to the quantity of water they have absorbed. When there is a sufficient supply of water certain fungoid growths will begin on the surface of the print under the glass, exactly like the growth of plants from the damp earth in a garden or conservatory. If there is iron in the paper here and there (which often happens), there will be spots of oxide of iron, or what we call rust, to give a pleasing variety of color, and if one of them happens to occur on a face, it must of course add greatly to its charm. Wooden backings are safer; and I have seen a room where the engravings with millboard behind them were all more or less spoiled by damp, while a large engraving with a thick wooden backing was entirely uninjured. Nevertheless, I would rather not trust to deal boards, as it is well known that deal is very absorbent of moisture. I remember having a heavy block of deal dead-wood removed from the hull of a boat, and when it was sawed through the water oozed freely out of every fiber. Had it been submitted to a powerful pressure, such as that from a hydraulic press, there can be no doubt that it would have been like squeezing a wetted sponge.

The necessity for careful precaution about the backing of framed engravings is not simply due to the permeability of walls that let the damp come through them; it may be also due to mere condensation on the inner surface of the wall even when it is well built and impermeable. This is best seen on a painted wall, as papers can absorb a great deal of water without letting it be immediately visible. In a very cold winter the external walls of a house become chilled throughout their mass, and when they are painted on the inside a sudden rise in temperature will produce visible condensation from the damp air, because the wall has not yet had time to raise its own temperature to that of the atmosphere. If there are engravings against the wall, they will suffer as much as if the wall itself were damp throughout its substance; for if the backings are absorbent they will drink in a quantity of moisture from the streaming wall-surface, which they will afterward slowly give off to the engraving for the encouragement of fungi and rust-spots. If oil-pictures are hung against a wall of this kind, the canvas will absorb moisture (unless certain precautions are taken, of which we may give an account presently), and then the increase in its bulk and area will cause it to hang loosely on the stretching-frames. The only way to combat condensation is by heating the air sufficiently to warm the walls themselves, when, of course, it must cease. Nature herself puts an end to it ultimately in the same way if the mild weather continues, but more slowly, as it takes some time to raise the temperature of a mass of stone by a gentle increase of heat. A thin inner wall, or wainscot separated by a little space from the

outer wall, may prevent condensation, because the thin partition, having little substance, rises easily in temperature. It would be quite worth while, in a house where valuable works of art are hung, to have thin inner walls with a circulation of warmed air between them and the thick external wall of the building. Tapestry is a very effective remedy against *visible* condensation, as it absorbs a great quantity of water, which it afterward gives off slowly into the atmosphere, and it may prevent or greatly diminish real condensation by being more easily warmed than a mass of stone can be.

The evil of injury from damp ought, however, to be combated as much as possible in the framing of the pictures and prints themselves. I will begin with prints because they are more common, so that the preservation of them concerns a greater number of my readers. In the first place, I would never trust to a backing of mill-board or pasteboard. A print may appear to be safe with such a backing for years, and then there may be a damper winter than usual, or you may go and live in a damper house, or you may be absent, and the house may not be heated with sufficient regularity, with the result of unexpected injury to your print. Why not make it safe from the beginning? It is easy to do this, so that the print may be hung on a damp wall without danger. Instead of mill-board put sheet-zinc for a backing. It need not be thick, and you can always get a piece of sheet-zinc as big as the largest print. By way of completing precautions I am careful to expel any moisture there may be in the print itself by heating it well over a spirit-lamp before inclosing it between the zinc and the glass, and instead of ordinary paste for the slips of paper that join the glass to the inside of the frame and the backing to the back of the frame I employ a strong solution of gum-lac in spirits of wine, which is impervious to moisture. The print is thus inclosed in a little space that is not only water-tight, but even air-tight as well, so that damp air can not get to it. I have tried the experiment of hanging prints so framed against the dampest walls that I could find, and they have passed more than one wet winter in perfect safety, while prints framed in the usual manner, with mill-board backings, were soon spoiled by mildew and rust-spots when hung upon the same walls. All that has just been said about the protection of framed prints applies with still greater force to water-color drawings, as a water-color is far more delicate in its constitution than a print, and therefore much less easily restored to its first appearance after it has been damaged by mildew.

Engravings can not be injured at all by light, the only effect of which is to bleach slightly the paper on which they are printed, but it appears to be quite an ascertained fact that water-color drawings fade when they are painted in full colors, though water-color monochromes in sepia, bistre, or Indian-ink may resist light almost indefinitely. If, then, the object is to preserve water-colors for future generations, they ought to be kept in cabinets; but it is also intelligible that the owner

of a collection may reasonably sacrifice a few drawings in his lifetime (and the sacrifice is only partial) to the satisfaction of seeing them more frequently and of ornamenting his walls with them. An intermediate plan with regard to water-color drawings is to have case-frames that allow one drawing to be easily substituted for another when the mounts are of the same size. The drawing is then exhibited for a short time only, and the owner has the refreshment of change on the walls of his room. The same plan may be followed with prints, simply for the sake of change.

With regard to the keeping of drawings in portfolios, there are reasons for believing that portfolios are not entirely safe. I have known a case in which prints in portfolios suffered visibly from damp, when every possible precaution seemed to have been taken for their preservation. The portfolios were kept in a closet six feet by eight, which was selected because it had no outer wall, and, though there was not a fireplace in the closet itself, the door of it opened on a room where a fire was constantly kept. The closet was believed to be the driest place in the house, and the house itself was not in a damp situation, being exposed to all the winds that blow, and built upon rather elevated ground. It happened, however, that the outer walls were built of a porous kind of sandstone, which retained moisture in the winter, and as the portfolios in which the prints were kept were made of mill-board, also a retainer of moisture, the prints were really damp in spite of the carefully chosen closet. They showed the signs of damp as much, almost, as if they had been hung upon a damp wall with a mill-board backing to each frame. It is plain, then, that the portfolio does not afford absolute security, and, indeed, the mill-board of which portfolios are commonly made is in itself an element of danger. Shallow tin boxes, with removable lids made like those of pill-boxes, are much safer than the common portfolio. I have alluded in another paper (on the "Poor Collector) * to cabinets with shelves of thin wood separated from each other by small intervals. Prints or water-color drawings may be kept in such cabinets without other protection than a sheet of paper as a protection against the small quantity of dust that finds its way into the interior. The cabinets should be placed in rooms where there are regular fires, and when the room is thoroughly warmed the doors of the cabinets should be occasionally left open and their contents exposed to the air. As to the wood of which they are to be made, it should be one of the least absorbent woods.

Well-closed cabinets or tin boxes are the best protection against dust. If portfolios are used, they ought always to have flaps, as without them dust is sure to get in and spoil the edges and sometimes part of the margins of the prints. The effect of dust in course of time is to discolor paper permanently. Suppose you lay a sheet of paper on another that is rather larger, so that the second shall not be entirely

* "Longman's Magazine," September, 1885.

covered by the first, and leave the two in a quiet place where dust will settle upon them, the unprotected margin of the second sheet will in course of time become discolored and show a contrast. Many drawings are so delicate that the dust can not be cleared from them without injuring the drawings themselves. Unfixed charcoals and pastels are the most delicate drawings of all, and require the most perfect protection against dust. The tidy housekeeper who dusts the unfinished charcoal on the easel is alluded to with horror in the little treatises on that art as the most destructive of all its enemies. As the charcoal itself is nothing but unfixed dust, it obeys the housekeeper's feather-brush only too readily, and disappears with the other dust that means nothing and is valueless. The housekeeper in such cases seems strikingly like the blind destructive forces of the natural world which respect genius and its productions no more than the commonest matter; she is like the sea which drowns Shelley and rolls the fragment of a Greek statue among its pebbles.

Protection against damp and dust may seem less necessary in the case of oil-pictures, but here also it has its importance. Unquestionably an oil-picture has a much stronger constitution than a water-color, yet it is admitted that some colors used in oil-paintings are affected unfavorably by moisture, and are insufficiently protected by pure oil. De Mayerne affirms that indigo fades in oil without varnish, but is durable under varnish, and the following quotation from Sir Charles Eastlake's "Materials for a History of Oil-Painting" will show the peculiar kind of danger that may arise from damp:

"The effect of moisture on verdigris, even when the color is mixed with oil, as noticed by Leonardo da Vinci, shows that such a vehicle, unless it be half resinified, affords no durable protection to some colors in humid climates; and the efficacy of resinous solutions, as hydrofuges, is at once exemplified by the fact that they answer the end which (unprepared) oil alone is insufficient to accomplish. Colors which are easily affected by humidity require to be protected according to the extent of the evil. Whatever precaution of this kind was requisite in Italy was doubly needed in Flanders. The superficial varnish which sufficed in the extreme case referred to by Leonardo was incorporated with the color by the oil-painters of the North. So in proportion as the Flemish painters adopted a thinner vehicle, the protecting varnish was applied on colors which the Italians could safely leave exposed, at all events till a general varnish was spread over the work. It will be remembered that this last method was unnecessary in the original Flemish process, according to which the colors, being more or less mixed with varnish, and being painted at once, remained glossy, and needed no additional defense."

It would not be safe, however, to conclude from this that a simple coat of varnish is a perfect insurance against damp, for varnish itself may be ultimately penetrated by damp, as Field showed in his chapter

on the "Fugacity of Colors." Here is Field's caution on the subject, which deserves attention :

"Others, with some reason, have imagined that when pigments are locked up in varnishes and oils they are safe from all possibility of change ; and there would be much more truth in this position if we had an impenetrable varnish—and even then it would not hold with respect to the action of light, however well it might exclude the influences of air and moisture ; but, in truth, varnishes and oils themselves yield to changes of temperature, *to the action of a humid atmosphere*, and to other chemical influences : their protection of color from change is, therefore, far from perfect."

The best way, then, to keep oil-pictures in a state of safety is not to trust much to their power of resisting damp, but to treat them just as if they were notoriously delicate things like water-color drawings, although in reality we know that their constitution is more robust. An oil-picture, it is well to remember, may be attacked by damp from behind. If it is hung on a damp wall, the canvas will absorb damp from the wall, like the mill-board behind a water-color, and this damp will reach the colors through the priming. The proof that canvases absorb damp is that they hang flaccid on their stretching-frames when there is much moisture in the atmosphere. It is some protection to have the back of the canvas protected by a coat of paint applied with varnish, but a still better protection is to have two canvases on the same stretching-frame, the one that bears the work of the painter and another behind it with a coat of paint on both sides. The practice of having two canvases on the same stretcher has been adopted by more than one modern painter for various reasons. One reason is that an accidental blow to the canvas from behind,* or an indentation from some angular object, may produce a fracture of the paint in the picture—a fracture not immediately visible, perhaps, but likely to show itself later.

It is generally of no use to propose anything that has not been already adopted to some extent in practice, but I may call attention to a plan which is successfully adopted by house-painters to protect wall-papers from damp. Their way (or one of their ways) is first to apply tin-foil to the wall, making it adhere by means of a thick coat of white-lead. This is found to be a good protection for the wall-paper which is pasted on the tin-foil. It would probably, in the same way, be an excellent protection for pictures if the double-canvas system were adopted and the under canvas covered with tin-foil upon

* Canvases are exposed to injuries of this nature in exhibitions chiefly, from the corners of other pictures that may be carelessly placed against them, before or after the exhibition. In private houses this danger is scarcely to be dreaded, but it is well to bear in mind that all people except painters believe that it does no harm to a canvas to lean it against the corner of a chair, a table, a box, or anything that may present itself conveniently.

white-lead. It has been remarked that a certain kind of decorative work used in the middle ages consisted of paint applied on tin-foil and protected by glass. Here was a double protection against damp, the glass before and the tin-foil behind, the glass answering to the varnish on a picture, but with more complete efficacy.

Glass is now largely used in the National Gallery for the protection of oil-pictures, but, unfortunately, the common objection that it does not allow the spectator to see the picture easily is but too well founded. What we really see is too often the reflection of a group of visitors to the gallery, almost as in a looking-glass. This happens especially when the picture is a dark one, and many of the finest old pictures are dark. We are sometimes told that it is an affair of focusing the eye, and that if we look as we ought to do at the picture itself, and not at the reflections, we shall not see the reflections. What really happens is this : If we look at the reflections of the visitors we see them wonderfully well, down to the most minute inventions of the feminine costume, and if we look at the picture we see it in a confused way intermingled with the reflections. This being so, it follows that private owners are not much encouraged to put their pictures under glass. It may be objected that water-colors are habitually protected in this way, and that no one complains. True, but in the first place, with regard to water-colors we have no choice, as any fly could spoil an unprotected water-color in a minute ; in the second place, a drawing in water-color is usually of small dimensions, so that it is more easily seen ; and, lastly, water-colors are generally paler than oil-pictures, so that they do not make such perfect mirrors. A dark old oil-picture with a sheet of plate-glass before it is, in certain lights, almost as good a mirror as if the glass were lined with quicksilver. We can hardly, then, include glass among the means to be recommended for protecting oil-pictures from damp, and must trust rather to the dryness of the atmosphere in which the pictures are kept ; and yet it is necessary to avoid excessive heating, which in certain cases produces or favors cracking and destroys by detaching paint from the priming of the canvas.

Canvas may not seem a very durable material, and yet, on the whole, it is preferable to wooden panels, for it may truly be said of wood, as it was said of the arch in architecture, that it is never at rest. It is always either swelling or contracting, and if a composite panel is not quite scientifically constructed, it is sure to tear itself and show fissures. Panels are therefore usually employed for small works only, and for these copper would be better still, though it has been used rarely. If a panel is well painted on the back, it will absorb damp less readily, and this precaution is very easily taken.

The art of removing a painting from an old to a new canvas is now so well understood that the operation, which many years ago seemed formidable, is now performed every day without attracting attention.

In this way an old picture gets a new lease of life; but the question remains whether the new lease might not be made longer, and indeed extended almost indefinitely, by impregnating the canvas with something that would increase its durability without weakening its substance. It is well known that the fiber of the threads in canvas is so weakened by the application of oil-paint, or oil alone, that it afterward is easily torn, and it is weakened in the same way by some other applications.

Oil-pictures unprotected by glass are always quietly accumulating a coat of dust and dirt, which, in course of time, unless it is occasionally removed, makes the hazardous process called "picture-cleaning" present itself as an ineluctable necessity if the work be visible at all. The two preservative cleanings are first simply dusting with a light feather-brush and an occasional careful washing with a soft rag, some warm water, and a *little* soap, but not a strong soap. I remember a house where a new Scotch house-maid, who was alarmingly industrious, was discovered one morning on the point of cleaning all the pictures in a certain room with soft-soap and a scrubbing-brush. She was about to apply the same treatment to the frames, on which there was a good deal of burnished gilding, which would all have immediately disappeared. As for the pictures themselves, if they were covered with old well-hardened varnish, they might possibly have survived, but unvarnished works would have been injured or destroyed. It is impossible to foresee what schemes a zealous servant may not carry into execution. Projecting ornaments on frames are always in danger from servants' dusters. I once possessed a plaster statuette, which was valuable because there were only three copies in existence, and every successive house-maid broke its arm off with a blow from the wooden stick which is inside a feather-brush. The arm was regularly glued on again for the next house-maid. The feather-brush looks a most innocent instrument, but the stick in it makes the house-maid formidable.

I once knew an old gentleman who possessed a picture of great value, the most important work of its master (one of the old masters) in existence. This picture was the pride and pleasure of his old age, and he could not help caressing it, as it were. From sheer love of it, he could not be satisfied with looking at it, but must needs touch it frequently also, and his way was to pass an oiled rag gently over its surface. I believe the oil he used was olive-oil (he was a Frenchman, and so there would always be olive-oil in the house for the salad), and as olive-oil never dries, or at least is the worst drier known,* perhaps it did not accumulate on the picture, but the dust must have stuck to it, and made a fresh application necessary from time to time merely to

* Field says that olive-oil is reported to have been used for painting in Italy in place of the desiccative oils, but he thinks it likely that it was only employed as a diluent. No painter in our climate would think of using olive-oil in any way whatever.

clean off the old one. Olive-oil does not dry properly, but it becomes sticky after long exposure to the air, and nothing could be better calculated to catch and retain dust. The wisdom of our ancestors made them rejoice in coats of varnish applied thickly over dirty pictures, to lock up the dirt between the paint and the varnish, and so preserve it for the delight of posterity. Our ancestors liked dingy pictures, and the dirtier they were the better they seem to have liked them. The President of the Irish Academy, in a witty speech that I regret not to have kept, said that in Ireland at the present day the public taste required that a picture should be very black, and that it should not cost more than six pounds. Now, dirt is a great help to darkness of complexion, as we all know by the faces of dirty boys in the streets, and, if darkness were considered a merit in these boys, it would be a great mistake to wash them.

The question of picture-cleaning is one of the most complicated that can be. Suppose you leave a very dirty picture as it is, do you see, can you possibly see, what the artist painted? Assuredly not; and why should decent people tolerate dirty pictures when they will not tolerate a dirty table-cloth? The answer is that, if the picture could be cleaned as safely as the table-cloth it would be done without hesitation, but that cleaning may *possibly* remove light glazes and scumblings along with the varnish, and that if these glazes, the finishing work of the artist, are once removed, no human being on earth, except the artist who painted the picture, can replace them. But, by the time a picture urgently wants cleaning, the painter has generally been for many years in his grave. Therefore, in having a picture cleaned you are risking that which can not be replaced. All this has been said before, but the arguments for and against picture-cleaning have usually been presented in a controversial manner by strong partisans of one side or the other, and, as I am not at all a partisan in the matter, I may be able to state the case more fairly. The choice of evils is this: To escape from the certain evil of leaving a picture concealed by the dirt upon it, you expose it to the possible evil of removing the finishing glazes. Anybody who has painted a picture knows what a disaster that is. The degree of the disaster varies with different artists, according to the importance of the glazes in their system of work. To remove the glazes, even partially, from a Titian is to destroy the picture, because he glazed a great deal, and what we all know as the rich Titian color required that method for its production; but, when a painter has used a more direct method, painting the intended color at once, or nearly so, then the removal of a glaze does not destroy the character of the picture, though it may diminish its beauty and charm. To remove a glaze, in any case, is to put the picture back from a finished to an unfinished state; this is exactly what is done, and the degree of destruction is in inverse ratio to the degree of advancement attained in that unfinished state. But, if the picture

is extremely dirty, then it is as if some other person had glazed unintelligently over the whole work, so that the original intentions of the artist are as much falsified in one direction by dirt as they are in another by taking the finish from his picture. The reasonable rule, then, would appear to be to clean pictures that really need it, but to avoid overcleaning with the most scrupulous care.

The removal of varnish is in some cases rendered absolutely necessary by a foolish practice that was occasionally resorted to by our fathers—the practice of tinting the varnish itself to give what they wrongly imagined to be tone. It was believed that anybody could varnish a picture; and, by one of those amazing delusions that take deep root in ignorant minds, it was thought that all the colors in a picture could be improved simultaneously by spreading one and the same transparent color over them.

The question whether it is right to paint upon pictures when repairing them may be better understood by considering one or two particular cases. I remember a house where the children were so much indulged that they were allowed to shoot with pop-guns and other engines at the family portraits, and they did this with such energy as actually to produce holes in the canvas—one large hole, for example, in the face of a lady who had been beautiful a hundred years ago. Now, if that picture came to you by inheritance in that state, the question about repainting would present itself to you in a practical form. You would have to determine whether the face was to remain in its damaged condition or to be repaired. To leave it damaged would be to destroy the effect of the picture on everybody's mind, because everybody would think of the hole, and how the accident happened, instead of thinking about the beauty or history of the lady or the merit of the painting. It seems, then, that it would be reasonable to have the picture repaired, and yet it is indisputable that to do this must be to introduce the work of another man. Everything, then, depends on the skill of the restorer. In such a case as that the restorer would begin by carefully laying together the jagged threads of the canvas, so that none should project, and he would probably put a backing to support them; then he would cover them with white-lead up to the level of the painted surface, and, when that was hard and dry, he would carefully color the white patch so as to replace what had been destroyed. Artists of considerable technical ability, but who have not the knack of producing salable pictures, sometimes attain such skill in the coloring of these patches that it becomes impossible to distinguish them after restoration, and the picture has all the appearance of an uninjured work. I remember some portraits from an old French château that were all dirt and holes; in fact, to call them dirty rags would scarcely have been an exaggeration, but the owner had a value for them, and wisely placed them in the hands of a very experienced painter. This artist knew a good cleaner, to whom he confided part of

the work, and who began by cleaning the pictures carefully and putting them all on new canvases.* In this state the new canvas showed through all the holes like the skin of a pauper through his shirt, and every one of these little islands of new canvas had to be colored up to the tint of the surrounding paint, or rather to be colored like the paint which had disappeared, the nature of it having to be guessed from what remained round about it. When there is no detail, as often happens in draperies and backgrounds, this is not extremely difficult, though it requires a well-trained eye to color; but when detail has to be invented exactly in the style of the picture, that is a different matter, which taxes the skill of the restorer to the utmost. However, there can be no question that when a picture is so injured as to present hiatuses, whether by holes in the canvas or by mere removal of the paint, it is an absolute necessity to have them filled as well as we can. Painting is not in the same position as literature in this respect. There are numerous unfinished lines in the "Æneid," and after the death of Virgil we are told that Augustus appointed a literary commission, empowered by him to remove those parts which were glaringly unfinished and defective (as Virgil himself had died before his own intended revisal of the poem); but we are also told that Augustus strictly forbade the revisers to add anything whatever of their own. We all feel that no hand but that of the author should add anything to a poem; we all prefer certain fragments of Coleridge and Shelley to any finishing that would involve additions by a reviser. In a minor degree we object to restoration in sculpture, though here we tolerate it to some extent. When a nose is broken from a bust, it is generally restored, and so is a finger on a hand; but prudent conservators of museums do not often attempt the restoration of an arm that has entirely disappeared. These distinctions, as well as our greater desire for the restoration of paintings, are all perfectly logical. A hiatus does not make a poem intolerable. The numerous small gaps in the "Æneid" have but a very slight effect in diminishing the reader's satisfaction, the reason being that they occur one at a time, and each little gap is forgotten in the interest of the next perfect opening of two pages; but in a picture all the gaps are seen at the same time, and distract our attention from the general beauty of the work. A Greek bust, however lovely, is a torment to us without its nose, and though the restored nose may not be so good as the lost original, it allows us to admire the beauties of the brow and chin in peace. If we shrink from the restoration of an arm, it is because we do not know enough about the arm that has been lost to replace it satisfactorily, but the lost arm is not spoiled; it is simply absent, and though there are loss and mutilation,

* When this is done the old canvases are entirely destroyed by friction without injuring the paint, which is then fixed on the new canvas. A painting is removed from a wooden panel by first planing the wood till it is very thin, after which what remains of the wood is destroyed entirely by the use of sand-paper and scrapers.

there is not a hiatus like an empty space which is inclosed within the four sides of a picture. The only exceptions to the necessity for restoration in damaged pictures are those cases in which a fragment of ancient painting is preserved less as a work of art than as an object of antiquarian interest. Then, of course, however mutilated, it must remain in its mutilated condition like all those things which are valuable as materials for antiquarian studies.

Vermin have to be guarded against carefully in the preservation of works of art. Drawings and engravings are generally protected either by portfolios or by glass, which prevent the droppings of flies from spotting them ; but I have seen prints spoiled in this way by being carelessly left upon a table for a very short time, when the flies took their opportunity and left their black dots. Their excrement is soluble in water, and can be removed easily from any hard substance while it is fresh, though it hardens and becomes less soluble afterward ; but on an engraving it is disastrous, as it sinks into the paper like a stain. It therefore becomes a necessary precaution, especially in summer, to cover a print that is left on a table, or, better still, never to leave prints on tables at all.

The worms that bore into wood are dangerous only to pictures on panels, and, as very few pictures are painted upon wood in these days, this enemy is not so much to be feared. When he attacks an old panel his holes may be stopped with a little marine glue, applied hot ; but it is curious how often worms will attack a thin piece of wood without penetrating to the other side. In two specimens before me, small panels three eighths of an inch thick, and about four inches by five, I find that in one case the worms have made twenty-two holes, not one of which has got through to the other side ; and in the other case there are twenty-five holes, of which only seven have as yet penetrated.

The only way to keep prints and drawings from the attacks of rats and mice is to have them always in closed cases if they are not framed, and, if the cases are of wood, it is a good precaution to have them covered with thin sheet-iron behind and beneath, while the front panels may be glazed. Tin boxes are a perfect protection against rodents, and so, of course, is glass. Common portfolios are a poor protection, as a rat willingly attacks them, and soon eats his way through to the prints ; in fact, common portfolios are in all ways unsafe, being of use only to keep order. The danger from rats and mice is always present, for even in places where they are unknown they may at any time suddenly make their appearance. A rat may find his way into your best protected room. I remember one summer's day—in broad daylight, too—seeing a large rat quietly descending into my study by means of a window-curtain, the window having been left open. He had walked along a little stone ledge that the architect had carried round the house as an ornament, which is a great convenience to rats. When a house is perfectly quiet at night a rat will wander about in the coolest man-

ner, and enter by any door that happens to be left ajar. In this way a fine black rat once got into my study and remained there for several days. I heard him distinctly behind certain heavy pieces of furniture, but could not get at him. He did a great deal of damage, though happily not to anything of much value, and he ended his career in a trap. Had I been away from home, the devastation caused by that one animal might have been serious. But his visit taught me a lesson, as he especially attacked portfolios, while the shallow tin boxes on shelves which I have adopted of late years entirely escaped his attentions. It is astonishing by what a narrow orifice a mouse will find her way into any place that she desires to visit. Drawers are sometimes so constructed that, although they fit well in front (for the sake of appearances), they are loose in the chest behind, and the consequence is that, if a mouse can get into the chest anywhere, she has all the drawers at her disposal. The first use she will make of any precious papers will probably be to tear them into little pieces and establish a comfortable nest in a corner.

In my article on "The Poor Collector" I touched briefly upon the question of frames. We have already noticed the curious fact that people who are strict about cleanliness in common household matters will tolerate dirty pictures. Very dirty frames are also tolerated in some public and private collections; in fact, I have seen collections where the notion that frames and pictures would be the better for being clean does not appear to have dawned upon the owner's mind. Surely, however, it is with these things as with all other things, cleanliness is pleasing in itself and an addition to the charm of beauty. One likes to see a pretty child with a clean face and an unspotted frock, though it might still be recognized as a pretty child if it lived in filth and squalor. In the case of pictures and their belongings, dirt is especially incongruous, because there can not be any poverty to excuse it. Pictures and their frames are superfluities in any case, and why tolerate a dirty superfluity?*

A word, in conclusion, may be said about the art of exhibiting things to advantage in private rooms. It is astonishing how few people understand the simple principle that some works of art may be injurious to others when shown by the side of them. For example, engravings are always killed by paintings, and the white margins of

* The one reason for dirty frames is the partial burnishing of the gilding. Oil-gilding can not be burnished; water-gilding, which takes burnish, can not be washed with water, and nothing but water will clean a fly-spotted, dirty frame effectually. Consequently a frame that has burnish upon it can only be dusted, and when it becomes really dirty it must be sent to the gilder; but, as regilding is expensive, it is postponed as long as possible—sometimes for a lifetime, and even for more than one generation. With oil-gilding only and *one thin coat* of varnish over the gilding (the varnish is nearly imperceptible if properly applied), a frame may be washed from time to time. This has been said already in the paper on "The Poor Collector," but is repeated here in a note for readers who have not that paper to refer to.

engravings diminish the luminous quality of paintings; yet there are people who hang paintings and engravings in the same room. Again, there are others who would not do that, but who will hang paintings together of which the style and sentiment are so absolutely incongruous that they can not avoid conflict, and require entirely different moods of mind for the right appreciation of them. Suppose you have a gravely furnished room, a library, and one or two portraits in it of thoughtful and serious men painted soberly and in quiet color, would it not evidently be a great mistake to admit into that room any picture whatever that should disturb the pensive tranquillity of the place? Fancy the effect if you admitted a gaudy modern portrait of an over-dressed lady with a smirk upon her face as she sat happy in her glare and glitter of millinery and trinkets! There ought to be in every room a certain prevailing note or mood of the human mind whatever it may be, and everything should be kept subordinate to that one dominant idea, with sufficient variety to avoid dullness, but without transgression of the limits prescribed by the idea. In a word, let us have ideal unity; let us avoid the incongruous. A room may contain different works of art, but, in a comprehensive sense, it is a work of art in itself, and the first necessity for every work of art is unity. If it is decided that the *note* of the room is to be cheerfulness, it is easy to keep faithful to that. Light in itself is an element of cheerfulness, so the wall-paper will be light. Water-colors are more cheerful than oil-paintings, because water-color painting is apparently slighter and more rapid; it conveys better the idea of felicitous dexterity. Water-colors, too, may have margins, and the white of the margins gives much light and gayety to a room. The frames must be gilded, because nothing is so cheerful as gilding; but they must not be heavy, because massiveness is oppressive to the imagination. The pictures themselves should be generally light, and the coloring as bright and gay as it can be without crudity. In such a room we do not want melancholy land-scapes or solemn-looking personages, but we want blue skies and sun-shine, merrily rippling waters, human life in youth or healthy maturity, happy in activity and love, not burdened with care and sorrow—all in that sweet dream-land of the poetic imagination—

> "Where the flowers ever blossom, the beams ever shine."

The opposite mood of thoughtful gravity is not by any means in-ferior as a motive, and it is more in consonance with the habitual feel-ings of mature age. The greatest of all artists have worked in the serious sense, and our noblest pictures, like our sweetest songs, "are those that tell of saddest thought," or, if not quite of the saddest, still of that quietly grave, reflective thought which is "far from all resort of mirth." Few paintings of the human face have such a permanent hold upon the memory, or are so often looked at, or for so many min-utes at once, as that picture by Francia in the Louvre which is simply

called the "Portrait of a Gentleman." Nobody knows anything whatever about the original, but the "gentleman" is so sad and thoughtful that we dream with him, and see the world through his melancholy eyes. In minor degrees many paintings have this kind of attraction; it is to be found in landscape as well as in portrait and history, and, if a few thoughtful works are brought together in the same room, without being neutralized by anything discordant in furniture and decoration, their effect upon the mind may be both durable and profound.—*Longman's Magazine.*

THE EVOLUTION OF LANGUAGE.

By M. A. HOVELACQUE.

EVEN if the study of words, as it is carried on by the method of the natural sciences, did not furnish evidence that all language is traceable back to primordial monosyllabic elements, observation of the language-processes in children would lead to that conclusion. Gestures and physiognomical motions preceded language proper, or articulate language; and on this point it is of interest to compare man with the monkeys, which are able to express a considerable variety of feelings by the play of the muscles of the forehead and the eyebrows, the lips, nose, and jaws. If asked on what vocalization depends, we should answer that it depends solely on a particular sensation being stronger than others. With the infant, voice is provoked at first by some uneasiness or suffering; and it is not till a later period that it responds to a feeling of comfort and satisfaction. But in either case the first emissions have nothing intentional about them, and there is no link of volition between the feeling and the vocal manifestation of it. The time comes at last when the child, beginning to perceive what is going on around him, remarks that they always come to his help when he has committed the act of utterance; and he has from that time learned by experiment the use of his vocal power. He employs it at first in a very general and vague way; but, as he is taught by experience, he learns to exercise it more precisely, more in accordance with his volition, and to adapt the vocal emission to the results he wishes to bring about. He also perceives the greater facility of expression it gives him, and so goes on developing his precious faculty as he continues to exercise it. Tylor has clearly brought out the fact that savages have in a high degree the power of expressing their ideas directly by emotional tones. These tones, or interjections, are the first elements of grammatical language. The same author has also remarked another fact, that children not more than three or four years old, for example, are wont to observe the play of features, attitude, and gestures of the

person who is speaking to them, in order to get the exact sense of the words which they hear.

We mention here, without dwelling upon it, that the faculty of language stands in close relation with a certain one of the frontal convolutions of the brain, which the inferior monkeys do not possess and which is found in a rudimentary state in the anthropoids, but the full acquisition and most complete development of which have made man, what he is, the master of articulate speech.

We thus perceive that the study of language belongs to the domain of the natural sciences. The objections that have been made to this view have little force with us. The first of them is that language is not transmitted with the blood. This confounds the transmission of the art of speech with that of the faculty of language. The faculty is hereditarily transmitted; it is intimately related to the cerebral development, and goes down with the structure, nature, and qualities of the brain. As to the way in which the transmitted organ shall perform its functions, the parents of the child are there to stimulate and direct it, and to teach their offspring how to use the faculty it has inherited from them. We must not confound the faculty with the use that may be made of it. That use is an art, which the child acquires by tradition. But, we repeat, in the period of formation of a language, sonorous expression is only the more intense formulation of an emotion, usually associated with mimicry, the general attitude and face-play, a formulation which has the advantage of being more striking to strangers. In any case, it originally required to be complemented by gesture; and peoples little advanced in civilization may still be cited, among whom conversation is difficult in the dark, where mimicry can not be brought in to aid it. Bonwick relates that the Tasmanians had to recur to gestures and signs to establish the exact sense of their words; and Spix and Martins say the same of some of the savages of South America, and Cranz of the Greenlanders. These observations are far from being the only ones that have been made to the same effect.

A sound reason for including the study of language among the natural sciences lies in the fact that no man or group of men is competent arbitrarily to change the structure of its language. Fashion may sometimes admit particular words or banish others, but that has nothing to do with the structure. The morphological evolution of language defies all convention, all encroachment; it goes on by virtue of its own force, more or less slowly or speedily, but without the fancy or the pleasure of men having any power to divert it from its course. In short, we must avoid confounding changes in the vocabulary with linguistic, or, as we might call them, morphological changes. Among some Polynesian peoples, words are sometimes abolished; they will cease, for example, to employ in conversation the syllables that occur in the name of a chief; some people of the Bantu race will not pro-

nounce any syllable that is found in the name of a near male relative. But these are special usages, temporary fashions, and have nothing whatever to do with the structure of the language. Then, again, we witness the creation of new words every day, but these words are always formed according to analogies with already existing words. They may be happy inventions or awkward attempts, but they are never pure creations or wholly fanciful.

A second objection to the classification of linguistic among scientific studies rests upon the fact that whole peoples, and even races, are capable of abandoning their own language and adopting another. The fact is undeniable ; but it is also undeniable that language is independent of history ; and, to take one example among many, we have seen Latin go on in its evolution in Gaul, Spain, and Roumania, after having been adopted by the barbarians.

It is proper to say something here about so-called mixed languages, which are, however, not at all hybrid in their structure, but have simply admitted foreign words into their vocabularies. With all the Persian and Arabic words it contains, the Turkish language is evidently and only Altaic. The Araucanian language, although it has received a host of Spanish words, is a purely American idiom. English is Germanic, although its vocabulary is loaded with words of Latin origin. The French language was introduced into England by the Norman conquest in the eleventh century. From the two languages which were then found in the presence of one another, the Anglo-Saxon and the French, it has been usually said that a mixed language was formed—the English. This assertion is very inexact, from the morphological point of view. French, after the conquest, became the language of the court and of justice, while it entered into the popular language, the Anglo-Saxon, only as to its vocabulary ; but there it made a deep impression. Of 43,000 words in the English language, as they occur in the dictionary, more than 29,000 are of Roman origin, while only 13,000 or 14,000 are of Germanic origin, or Anglo-Saxon ; yet the English language is wholly Germanic in its structure. The remains of the declensions of nouns and of the conjugations of verbs are Germanic, with no Latin about them. Another example of the kind is found in the Basque language, three quarters of the vocabulary of which is to-day Romanic ; yet the fact does not prevent the language from having a peculiarly individual structure and form wholly free from Romanic elements in its grammar.

In short, the processes of linguistic study—which have nothing in common with those of the study of philology—demonstrate that the linguist studies the anatomy of forms just as the botanist and zoölogist do.

Another objection to the scientific view of linguistics is more specious, but not more solid. It is that, since articulate language can not be produced without vocal organs, it can not be regarded as an

independent organism; besides, the sounds or vocal emissions do not become a language till they acquire significance by means of an operation that escapes us. It is easy to answer to this that, while language is in relation with a mental operation, it nevertheless constitutes a fact which is perceived by a sense—the sense of hearing. Of course, it is only in the abstract sense that we can regard language as an organism, but there is no doubt that in reality it behaves like an organism, and that it is in a constant state of evolution. And it is to this condition of evolution that I invite attention.

The phases of this evolution, as we understand it, are those of formation, growth, maturity, and decay. The variation is continual. Languages arise, are developed, pass on to decadence, and perish, like other organized beings. That their historical development is modified in the course of ages, according to certain conditions, is incontestable; but the observer of these modifications never sees in them anything other than phenomena of natural evolution. The evident proof of this fact is that the evolution is, as a whole, the same in linguistic families essentially different from one another.

Abel Rémusat has, in his "Recherches sur les langues tartares," indicated the general nature of the evolution of idioms: "In studying them attentively," he says, "we are tempted to believe that they are as constant in their march as the physical constitution that gives origin to them. . . . Possibly there prevails in languages less of the arbitrary than we have been accustomed to suppose; and, if we bring to their study the necessary care, we may be able to find in them signs as sure, as pronounced, and as characteristic as those which we can deduce from physiognomy, the color of the skin, or any other physical and external peculiarity." This "necessary care" has been carried into the study of languages, and we shall see to what conclusions it has led us.

We are not acquainted with any language in its embryonic condition, if such a term is admissible. All of the languages submitted to our direct observation, even those of the most primitive stage, have passed the period of formation, which was prehistoric, and are now in the historical period, and generally in their decay. But by methodically separating and comparing their formative elements we can put ourselves, as it were, into the period of their formation.

The result of such comparative researches has confirmed the theory proposed in 1818 by William Schlegel, that languages first passed through a monosyllabic period; that some of them rose to the stage of development called the agglutinative; and that a small number of these last reach a later stage of flexion. The structure of the languages of the first class is simple, that of the second class is complex, and that of the third class is still more complex.

In the first phase of language, the root and the word are one, and each word-root or root-word is monosyllabic. The phrase is therefore

a pure and simple succession of isolated roots. It is evident that the first process of elocution was of this character. Expression was found in uttering, one after another, monosyllables which were sometimes undoubtedly onomatopoetic—imitations of noises, sounds, and cries.

Existing monosyllabic languages have singularly improved upon this primitive process, while they have still remained monosyllabic. They have not created grammar, there being no structure in their words, but they have created a syntax. This syntax consists in the position in the phrase given to the different root-words. The place which any monosyllable occupies in the phrase determines the meaning of that monosyllable. The same process of syntactical arrangement comes back into use in the existing analytical languages that are most advanced in decadence. When, for example, we say in English, "Peter likes John," we are obliged to put the word Peter at the beginning of the phrase, and John at the end; for both words have lost every morphological distinction that could show which of them is the subject and which the object. It is not so in the synthetical languages in which the subject and the object are distinguished by the form of the word, and position in the phrase is of little importance. Thus, to say in Latin that the Helvetians sent legates, we say indifferently, *Helvetii legatos miserunt*, or *Legatos miserunt Helvetii;* the form in which the two nouns are put defining their respective functions.

In Chinese, the root which is to be the subject, or nominative in a phrase, takes its place before the root that has the significance of a verb. By thus assigning to the subject-word a fixed place in the phrase, the want of the grammatical elements which in Greek and Latin characterize the nominative case is obviated. In a monosyllabic language, in short, there is no grammar; there are no substantive forms, no verbal forms, or declensions, or conjugations, or gender, moods, or tenses, nothing but syntax, or "putting together." This, moreover, is what we shall more easily grasp in studying the transition from monosyllablism to agglutination, or the passage from the first to the second linguistic phase.

This transition or evolution takes place in a very simple way. Some word-roots abdicate a part of their meaning and become simple elements of relation, while others retain their full and independent signification. In Chinese and in other existing monosyllabic languages, we find this division of words into "full" words (which we may translate into English by a noun or a verb) and "vacant" words, the primary sense of which has gradually become obscured, and which have come to define more exactly or limit the broad sense of the "full" words. It is an interesting fact that a similar process has been employed at a much later stage in languages which have reached a high degree of development. Thus, in Latin, besides the word *circus*, a circle, we find *circum*, around, a kind of vacant word, denoting

only relation; and examples of the kind might be multiplied in that language. So in Chinese, a monosyllabic language, the word for with, the sign of the instrumental case ("with the arm," "with a stick") is simply the root which when a "full" word signifies to make use of.

In the monosyllabic languages, the full words and the vacant words follow one another without ever amalgamating; that is, the roots are always isolated from each other, and there is never a word of several syllables. It is true that we can form something like compounds by bringing two words together, but without uniting them. Thus, in Chinese, the words *fú*, father, and *mù*, mother, brought together under the form of *fú-mù*, signify parents; and in the same way the words for "far" and "near" are made to signify distance. But there is nothing of derivation in this. Neither of the two words serves as an element of relation to the other, but each keeps all of its personality.

A step further is taken at a certain moment of linguistic development. The word indicating relation, the vacant word, is joined to the full word, and a polysyllabic form arises. A new word is formed, consisting of something else than a simple root, by the agglomeration of different elements, and we are in a secondary or agglutinative stage. We have no longer two full words juxtaposed to form a composite word; but an annexation to the principal word of a word playing the part of a secondary derivative and defining the relations of the root to which it is joined. When this derivative element is placed after the radical form, it is called a suffix; when it is placed at the beginning of the word, it is a prefix. Sometimes it is intercalated in the body of the word, and is then called an infix; but that method of derivation is rare.

It may be added that there are no limitations to derivation. The derived word may be the beginning of a second compound, and this of a third, and so on. Thus, in Magyar, the derivative *zárat* means he causes to shut, and *zárhat* he can shut; then, by a secondary derivation, we form *zárathat*, he can cause to shut. In like manner, *záratgat*, he causes to shut often, is a secondary, and *záratgathat*, he can cause to shut often, is a tertiary derivative. The languages of the third period of evolution, Latin for example, present a considerable number of these secondary and tertiary derivatives. The Latin word *pater*, father, is a primary derivative, of which the full or radical element is *pa* and the limiting element is *ter*. *Paternus*, whence our paternal, is a secondary, and *paternitas*, corresponding with our paternity, is a tertiary derivative. But our languages have not the extraordinary facility in derivation possessed by some simply agglutinative idioms. Thus, in the Turkish language, a single word may be made to introduce an indefinite number of ideas: as, *sèvmèk*, to love; *sèvmèmèk*, not to love; *sèvilmèk*, to be loved; *sèvilmèmèk*, not to be loved; *sèvdirmèk*, to make to love; *sèvdirmèmèk*, not to make to

love ; *sèvinmèk*, to love one's self ; and so on, in which the derivative elements indicate, in the various forms, negation, causation, the reflexive quality, and other ideas, which in our language have to be expressed by separate words.

The larger number of languages are in the secondary or agglutinative stage. Among them are the negro, Malay, Polynesian, Dravidian, Altaic, Basque, and American languages or families of languages. But community of structure is no sign of relationship ; it only indicates that two or more languages are in the same stage of evolution.

Some languages have made but little progress in agglutination, while others have advanced a great way in it. Some of the Western African negro languages still use, with agglutinative forms, processes that appertain to the monosyllabic structure. These are not cases of return to ancient forms, but are survivals of ancient forms in the midst of more complex formations. Some idioms, also, perpetually betray the evidences of the passage from monosyllablism to agglutination. Such languages have no literary value, and are not at all prominent ; but they are like those obscure vegetable or animal species which are frequently richer in facts for the botanist or zoölogist than other species that are usually esteemed much more useful or beautiful.

It is not quite so easy to explain the phenomena of the evolution from agglutination to flexion. The principle by which the evolution takes place is that of a phonic modification of the root. In the Indo-European languages, among which are included the Sanskrit, Persian, Greek, Latin, etc., evolution took place, according to M. Victor Henry, not only in this way, but by an agglutination of infixes also. But this point is not yet cleared up.

If we consider the ancient languages of the Indo-European family —Sanskrit, Greek, and Latin—we shall find that they are in different degrees synthetic ; while, if we examine the characters of the modern branches of the family, we shall discover that they are analytical. This effect is the work of linguistic decadence, which has been less rapid in the Slavic languages than in the Germanic, in the Germanic than in the Romanic languages.

This decadence, which constitutes a new phase of evolution, is not brought about by chance. Regarding it phonetically, we see in it the results of the least effort. Diphthongs are condensed, as when in Latin *veicos* and *deivos* become *vicus* and *deus*. Assimilation takes place among the consonants, as when *noctem*, night, becomes *notte*, or *septem*, seven, *sette*, or when the earlier *s*-sound is softened into a simple aspirate. A considerable number of phonetic variations, which baffle persons not familiar with linguistic studies, are justified by comparison with other words.

Grammatical decadence also corresponds with a simplification. The

ancient Indo-European language, of which the comparison of the Sanskrit, Greek, Latin, Slavic, and Germanic languages has enabled us to restore the important forms, possessed a rich system of declensions. Latin lost a part of its cases, and had of others only vestiges. Old French went a step further, and only kept two cases, the subject and the object cases ; and even this greatly simplified declension disappeared in the fourteenth century, and the French language became wholly analytical, yet not without preserving traces of the two cases of the middle ages in the double forms of some of its words.

The simplification of declension appears in all modern languages. In Persian there is, properly, no declension. The dative and accusative are expressed by adding prepositions to the noun, the genitive by syntactical arrangement. Modern Greek has lost the forms of the dual number and of the dative case. Among the Semitic languages, current or spoken Arabic has dropped the terminations by which the cases are distinguished in literary Arabic. In vulgar Arabic the cases are distinguished by the position of the words or the use of prepositions. The same analytical phenomena may be observed in the conjugations. In the original Indo-European system, the perfect was formed by the reduplication of the root. Latin formed its perfects by compositions of words in which the auxiliaries were partly disguised as terminations, and in modern languages the analytical process has been further carried out. The same process is going on in the future tenses, which in English have reached the ultimate stage of it. Decadence sometimes proceeds by the primary value of a form or a word being forgotten. French affords some curious examples of this. Take the words *luette*, uvula, and *lierre*, ivy, which are from the Latin *uveta*, *hedera*. In old French they were written *uette*, *hierre*. When the article was prefixed they appeared as *l'uette*, *l'hierre*. Then the meaning of the article was forgotten or misconceived, and it was written as a part of the words. It then had to be supplied again, and so the French say now *la luette*, *la lierre*. This deformation took place naturally and without intention.

I come now to speak of the struggle for existence which is constantly going on between languages geographically near to one another and between different dialects of the same language. Unless one of the idioms is specially favored in the struggle by political circumstances, it is evident that the one which is most advanced in evolution will gain upon those which are less advanced : this fact can be established by many examples. Thus, in the territory which is now France, Latin, introduced into Gaul by a relatively small number of persons, shortly surpassed the Celtic dialects. The French language is wholly Latin, having retained from the Celtic only a few recollections in its vocabulary ; but, when the Germans established themselves in a large part of Gaul, instead of giving their language to the conquered population, they abandoned it in the end and adopted the neo-Latin,

which afterward became French; and the French language is no more Germanic than it is Celtic. Natural selection has caused the disappearance of a considerable number of idioms. Languages which come into conflict are like groups of animals that have to struggle with one another for existence. They must gain upon their competitors, or resign themselves to disappear before them. Just as, in the contest for life and development, the best-armed races finally prevail over those which are less favored, so languages which are best served by their own aptitudes and by external circumstances prevail over those whose evolutive force is less considerable, and over those which historical conditions have less well prepared for the combat. In France, the French, the ancient *langue d'oil* gradually supplanted the *langue d'oc*, the Corsican, the Breton, the Flemish, and the Basque. In the British Islands, English eclipsed the Celtic languages, Irish, Scotch, Manx, and Gaelic, and will shortly have supplanted the Cornish. German has overcome a number of Slavic idioms.

Another kind of selection is going on within the language itself with reference to the use of particular forms and words. In reference to this, the study of dialects is of great interest. Dialects should not be regarded as degenerate conditions of literary languages. These languages are simply fortunate dialects, whose rival dialects have been less favored. We are constantly meeting in dialects forms and words which their sister literary languages have not preserved; and this fact gives dialects an important place in the study of the natural history of language.

The fact that some idioms have been lost has been disadvantageous to linguistic studies because intermediate forms have thereby disappeared, the existence of which would have explained many living forms. In this, again, we have presented in language something comparable to what has taken place among animals and plants. Moreover, a linguistic species, once extinct, can never be brought back to life. It has been only a little while since the Tasmanians disappeared, and their language with them. Those people who were the product of a long ethnic evolution can never be brought back; no more can a language like theirs, which was also the product of a long development, be revived. So in the world of animals and plants, the disappearance of a species is always definitive; to bring it back to a new life would require the impossible return of the conditions of every kind which had brought it up to the stage which it had reached at the moment of its extinction.

I should be satisfied if I could believe that this review, perhaps too rapid, has made evident the interesting fact of the life and evolution of languages. To say *life* of language does not seem sufficient, for that word only gives the idea of a simple state of activity. The word *evolution* is more rigorously exact. We find ourselves, in fact, in the presence of successive developments of an entirely natural order. The

organic perfectionment of the brain gives to the highest of the primates the faculty of articulate speech ; that faculty, brought into play, gives rise to an extremely rudimentary system of expression, the source of which, as Lucretius has observed with much force and justice, lies in an imperious need. This need is, in fact, the creator of words. Gradually the monosyllabic words become differentiated into principal words and words of secondary signification. A new phase begins with the closer association of words, and the different processes of derivation develop themselves more and more. The third phase is characterized at first by a remarkable synthetic process, which soon, however, undergoes simplification, and yields under the influence of a more rapid civilization to a more and more accentuated analytical precision. The ultimate form has evidently not yet been reached by the English and French languages ; but since language was born with man, and is his single characteristic, though laboriously and slowly developed as all his powers have expanded, it is destined to be transformed into more and more perfect forms of expression as man himself continues to ascend in the scale of superiority. — *Translated for the Popular Science Monthly from the Revue Scientifique.*

THE SCIENCE OF FLAT-FISH, OR SOLES AND TURBOT.

"ONCE upon a time," says that delicious creation of Lewis Carroll's, the Mock Turtle, "I was a real turtle!" Once upon a time, the modern sole might with greater truth plaintively observe, I was a very respectable sort of a young codfish. In those happy days, my head was not unsymmetrically twisted and distracted all on one side ; my mouth did not open laterally instead of vertically ; my two eyes were not incongruously congregated on the right half of my distorted visage ; and my whole body was not arrayed, like a Portland convict's, in a party-colored suit, dark-brown on the right and fleshy-white on the left department of my unfortunate person. When I was young and innocent, I looked externally very much like any other swimming thing, except, to be sure, that I was perfectly transparent, like a speck of jelly-fish. I had one eye on each side of my head ; my face and mouth were a model of symmetry ; and I swam upright like the rest of my kind, instead of all on one side after the bad habit of my own immediate family. Such, in fact, is the true portrait of the baby sole, for the first few days after it has been duly hatched out of the eggs deposited on the shallow spawning-places by the mother-fishes.

After some weeks, however, a change comes o'er the spirit of the young flat-fish's dream of freedom. In his very early life he is a wan-

derer and a vagabond on the face of the waters, leading what the scientific men prettily describe as a pelagic existence, and much more frequently met with in the open sea than among the shallows and sand-banks which are to form the refuge of his maturer years. But soon his *Wanderjähre* are fairly over: the transparency of early youth fades out with him exactly as it fades out in the human subject: he begins to seek the recesses of the sea, settles down quietly in a comfortable hollow, and gives up his youthful Bohemian aspirations in favor of safety and respectability on a sandy bottom. This, of course, is all as it should be; in thus sacrificing freedom to the necessities of existence he only follows the universal rule of animated nature. But, like all the rest of us when we settle down into our final groove, he shortly begins to develop a tendency toward distinct one-sidedness. Lying flat on the sand upon his left cheek and side, he quickly undergoes a strange metamorphosis from the perfect and symmetrical to the lopsided condition. His left eye, having now nothing in particular to look at on the sands below, takes naturally to squinting as hard as it can round the corner, to observe the world above it; and so effectually does it manage to squint that it at last pulls all the socket and surrounding parts clean round the head to the right or upper surface. In short, the young sole lies on his left side till that half of his face (except the mouth) is compelled to twist itself round to the opposite cheek, thus giving him through life the appearance constantly deprecated by nurses who meet all unilateral grimaces on the part of their charges with the awful suggestion, "Suppose you were to be struck so!" The young sole is actually struck so, and remains in that distressing condition ever afterward.

This singular early history of the individual sole evidently recapitulates for us in brief the evolutionary history of the entire group to which he belongs. It is pretty clear (to believers, at least) that the prime ancestor of all the flat-fish was a sort of cod, and that his descendants only acquired their existing flatness by long persistence in the pernicious habit of lying always entirely on one side. Why the primeval flat-fish first took to this queer custom is equally easy to understand. Soles, turbots, plaice, brill, and other members of the flat-fish family are all, as we well know, very excellent edible fishes. Their edibility is as highly appreciated by the sharks and dog-fish as by the enlightened public of a Christian land. Moreover, they are ill-provided with any external protection, having neither fierce jaws, like the pike and shark; efficient weapons of attack, like the sword-fish and the electric eel; or stout defensive armor, like the globe-fish, the file-fish, and the bony pike, whose outer covering is as effectually repellent as that of a tortoise, an armadillo, or a hedgehog. The connection between these apparently dissimilar facts is by no means an artificial one. Fish which possess one form of protection seldom require the additional aid of another: for example, all the electric fish have scaleless bodies,

for the very simple reason that no unwary larger species is at all likely to make an attempt to bite them across the middle; if it did, it would soon retire with a profound respect through all its future life for the latent resources of electrical science. But the defenseless ancestor of the poor flat-fishes was quite devoid of any such offensive or defensive armor, and, if he was to survive at all, he must look about (metaphorically speaking) for some other means of sharing in the survival of the fittest. He found it in the now-ingrained habit of skulking unperceived on the sandy bottom. By that plan he escaped the notice of his ever-present and watchful enemies. He followed (unconsciously) the good advice of the Roman poet: *bene latuit.*

But, when the father of all soles (turbot, brill, and dabs included) first took to the family trick of lying motionless on the sea-bottom, two courses lay open before him. (That there were not three was probably due to the enforced absence of Mr. Gladstone.) He might either have lain flat on his under-surface, like the rays and skates, in which case he would, of course, have flattened out symmetrically sidewise, with both his eyes in their normal position, or he might have lain on the right or left side exclusively, in which case one side would soon practically come to be regarded as the top and the other side as the bottom surface. For some now almost incomprehensible reason, the father of all soles chose the latter and more apparently uncomfortable of these two possible alternatives. Imagine yourself to lie (as a baby) on your left cheek till your left eye gradually twists round to a new position close beside its right neighbor, while your mouth still continues to open in the middle of your face as before, and you will have some faint comparative picture of the personal evolution of an infant sole. Only you must, of course, remember that this curious result of hereditary squinting, transmitted in unbroken order through so many generations, is greatly facilitated by the cartilaginous nature of the skull in young flat-fish.

When once the young sole has taken permanently to lying on his left side, he is no longer able to swim vertically; he can only wriggle along sidewise on the bottom, with a peculiarly slow, sinuous, and undulating motion. In fact, it would be a positive disadvantage to him to show himself in the upper waters, and for this very purpose Nature, with her usual foresight, has deprived him altogether of a swim-bladder, by whose aid most other fishes constantly regulate their specific gravity, so as to rise or sink at will in the surrounding medium. Some people may indeed express surprise at learning that fish know anything at all about specific gravity; but as they probably manage the alteration quite unconsciously, just as we ourselves move our limbs without ever for a moment reflecting that we are pulling on the flexor or extensor muscles, this objection may fairly be left unanswered.

The way in which Nature has worked in depriving the sole of a swim-bladder is no doubt the simple and popular one of natural selec-

tion; in other words, she has managed it by the soles with swim-bladders being always promptly devoured. Originally, we may well suppose, the ancestral sole, before he began to be a sole at all (if I may be permitted that frank Hibernicism), possessed this useful aërostatic organ just like all other kinds of fishes. But when once he took to lurking on the bottom and trying to pass himself off as merely a bit of the surrounding sand-bank, the article in question would obviously be disadvantageous to him under his altered circumstances. A bit of the sand-bank which elevates itself vertically in the water on a couple of side-fins is sure to attract the unfavorable attention of the neighboring dog-fish, who love soles like human epicures. Accordingly, every aspiring sole that ever sought to rise in the world with undue levity was sure to be snapped up by a passing foe, who thus effectually prevented it from passing on its own peculiar aspirations and swim-bladder to future generations. On the other hand, the unaspiring soles that hugged the bottom and were content to flounder along contentedly sidewise, instead of assuming the perpendicular, for the sake of appearances, at the peril of their lives, lived and flourished to a good old age, and left many successive relays of spawn to continue their kind in later ages. The swim-bladder would thus gradually atrophy from disuse, just as always happens in the long run with practically functionless and obsolete organs. The modern sole bears about perpetually in his own person the mark of his unenergetic and sluggish ancestry.

At the same time that the young sole, setting up in life on his own account, begins to lie on his left side only, and acquires his adult obliquity of vision, another singular and closely correlated change begins to affect his personal appearance. He started in life, you will remember, as a transparent body; and this transparency is commonly found in a great many of the earliest and lowest vertebrate organisms. Professor Ray Lankester, indeed, who is certainly far enough from being a fanciful or imaginative person, has shown some grounds for believing that our earliest recognizable ancestor, the primitive vertebrate, now best represented by that queer little mud-fish, the lancelet, as well as by the too famous and much-abused ascidian larva, was himself perfectly translucent. One result of this ancient transparency we still carry about with us in our own organization. The eye of man and of other higher animals, instead of being a modification of the skin (as is the case with the organ of vision in invertebrates generally), consists essentially of a sort of bag or projection from the brain, turned inside out like the finger of a glove, and made by a very irregular arrangement to reach at last the outside of the face. In the act of being formed, the human eye in fact buds out from the body of the brain, and gradually elongates itself upon a sort of stalk or handle, afterward known as the optic nerve. Professor Lankester suggests, as a probable explanation of this quaint and apparently rather roundabout ar-

rangement, that our primitive ancestor was as clear as glass, and had his eye inside his brain, as is still the case with the ascidian larva. As soon as his descendants began to grow opaque, the eye was forced to push itself outward, so as to reach the surface of the body; and thus at last, we may imagine, it came to occupy its present prominent position on the full front of all vertebrate animals.

To return to our sole, however, whom I have left too long waiting in the sand to undergo his next transformation: as soon as he has selected a side on which to lie, he begins to grow dark, and a pigmentary matter forms itself on the upper surface exposed to the light. This is a very common effect of exposure, sufficiently familiar to ladies and others, and therefore hardly calling for deliberate explanation. But the particular form which the coloring takes in the true sole and in various other kinds of flat-fish is very characteristic, and its origin is one of the most interesting illustrations of natural selection to be found within the whole range of animated nature. In every case it exactly resembles the coloration of the ground on which the particular species habitually reposes. For example, the edible sole lies always on sandy banks, and the spots upon its surface are so precisely similar to the sand around it that in an aquarium, even when you actually know from the label that there is a sole to be found in a particular tank, you can hardly ever manage to spot him as long as he lies perfectly quiet on the uniform bottom. Turbot, on the other hand, which prefers a more irregular pebbly bed, is darker brown in color, and has the body covered on its upper side with little bony tubercles, which closely simulate the uneven surface of the banks on which it basks. The plaice, again, a lover of open, stony spots, where small shingle of various sorts is collected together in variegated masses, has its top side beautifully dappled with orange-red spots, which assimilate it in hue to the party-colored ledges whereon it rests. In this last case the brighter dabs of color undoubtedly represent the bits of carnelian and other brilliant pebbles, whose tints of course are far more distinct when seen in water by refracted light than when looked at dry in the white and common daylight. We all know how much prettier pebbles always seem when picked up wet on the sea-shore than under any other circumstances.

Some few flat-fish even possess the chameleon power of altering their color, in accordance with the nature of the bottom on which they are lying. The change is managed by pressing outward or inward certain layers of pigment-cells, whose combination produces the desired hues.

The origin of this protective coloration must once more be set down to that *deus ex machinâ* of modern biology, natural selection. In the beginning, those flat-fish which happened to be more or less spotted and speckled would be most likely to escape the notice of their ever-watchful and rapacious foes; while those which were uniformly

colored brown or gray, and still more those which were actually black or light pink, would be at once spotted, snapped up, and devoured. Hence in every generation the ever-surviving sole or turbot was the one whose spots happened most closely to harmonize with the general coloration of the surrounding bottom. As these survivors would alone intermarry and bring up future families of like-minded habits, it would naturally result that the coloration would become fixed and settled as a hereditary type in each particular species. Meanwhile, the eyes of the enemies of flat-fish, ever on the lookout for a nice juicy plaice or flounder, would become educated by experience, and would grow sharper and ever sharper in detecting the flimsy pretenses of insufficiently imitative or irregularly colored individuals. Natural selection means in this case selection by the hungry jaws of starving dog-fish. When once the intelligent dog-fish has learned to appreciate the fact that all is not sand that looks sandy, you may be sure he exercises a most vigilant superintendence over every bank he happens to come upon. None but the most absolutely indistinguishable soles are at all likely to escape his interested scrutiny.

The mere nature of the bottom upon which they lie has thus helped to become a differentiating agency for the various species and varieties of flat-fish. Soles, which easily enough avoid detection on the sandy flats, would soon be spotted and exterminated among the pebbly ridges beloved of plaice, or the shingly ledge especially affected by the rough-knobbed turbot. Flounders, whose coloring exactly adapts them to the soft ooze and shallow mud-banks at the mouths of rivers, would prove quite out of place on the deep pools of the channel, covered with pale-yellow sand, where the pretty lemon sole is most at home. In the case of the true sole, too, the long, graceful, sinuous fringe of fins is so arranged that it can fit accurately to the surface on which the fish is lying, and so add in a great measure to the appearance of continuity with the neighboring sands. A sole, settling down on a ribbed patch of sand, can thus accommodate its shape to the underlying undulations, so that it is almost impossible to distinguish its outline, even when you know exactly where to look for it. Soles are very clever at choosing such deceptive hiding-places, and very seldom openly expose themselves on a flat horizontal surface. Moreover, whenever they settle, they take care partially to bury themselves in the sand, with a curious sidelong flapping motion, and so still more effectually screen themselves from intending observers.

I may note in passing that such correspondence in color with the general hue of the surrounding medium is especially common wherever a single tone predominates largely in the wider aspect of nature. Arctic animals, as everybody knows, are always white. Ptarmigan and northern hares put on a snowy coat among the snows of winter. The uncommercial stoat needlessly transforms himself on the approach of cold weather into the expensive and much-persecuted ermine.

Imagine for a moment the chances of life possessed by a bright scarlet animal among the snow-fields of Greenland, and one can see at once the absolute necessity for this unvarying protective coloration. Even a royal duke would scarcely venture to approve of flaring red uniforms under such conditions. All the conspicuous creatures get immediately weeded out by their carnivorous enemies, owing to their too great obtrusiveness and loudness of dress; while those alone survive which exactly conform to the fashionable whiteness of external nature. So, too, in the desert every bird, lizard, grasshopper, butterfly, and cricket is uniformly dressed in light sand-color. The intrusive red or blue butterfly from neighboring flowery fields gets promptly eaten up by the local bird, whose plumage he can not distinguish from the sand around it. The intrusive scarlet or green bird from neighboring forests finds the bread taken out of his mouth by the too severe competition of his desert brethren, who can steal upon the native grasshoppers unperceived, while he himself acts upon them like a red danger-signal, and is as sedulously avoided by the invisible insects as if he meant intentionally to advertise in flaming posters his own hostile and destructive purpose.

In short, sand-haunting creatures are and always must be necessarily sand-colored.

A few tropical flat-fish, however, living as they do among the brilliant corals, pink sea-anemones, gorgeous holothurians, and banded shells of the Southern seas, are beautifully and vividly spotted and colored with the liveliest patterns. In this case the necessity for protection compels the fish to adopt the exactly opposite tactics. All those young beginners which happen to show any tendency to plain brown coloring are sure to be recognized as fish, and get promptly eaten up among their bright surroundings; only those which look most like the neighboring inedible and stinging nondescripts stand any chance of escaping with their precious lives. A Quaker garb which would easily pass unobserved in the murky English Channel would become at once conspicuous by contrast among the brilliant organisms of Amboyna or Tahiti. This beautifully proves the relativity of all things, as philosophers put it. Ordinary people express the same idea in simpler language by saying that circumstances alter cases.

Most of our English flat-fish lie consistently on one side, and that the left; they keep their right eye always uppermost. But the turbot and the brill reverse this arrangement, having the left side on top and colored, while the right side is below and white. Two other fish, known as the fluke and the megrim, but not received in polite society, follow the example of their fashionable friends in this respect. But in no case are these habits perfectly ingrained; now and then one meets with a left-sided sole or a right-sided turbot, which looks as though a great deal were left to the mere taste and fancy of the individual flat-

fish. Some have taken to lying most frequently on one side and some on the other; but it is interesting to note that when a normally right-sided individual has happened to lie with his left side uppermost that side becomes colored and distorted exactly the same as in his more correct brethren. This shows how purely acquired the whole habit must be. It points back clearly to the days when flat-fish were still merely a sort of cod, and suggests that their transformation into the unsymmetrical condition is merely a matter of deliberate choice on their own part. Indeed, there seems good reason to believe that many young flat-fish never undergo this change at all, but swimming about freely in the open sea assume that peculiarly elongated and strange form known as the leptocephalic.

I don't mean to say that all leptocephali are originally the offspring of flat-fishes, but some probably are; and so a word or two about these monstrous oceanic idiots and imbeciles may not be here out of place.

Lolling about lazily in the open ocean a number of small, long, ribbon-like fish are frequently found, quite transparent and glassy in appearance, with no head at all to speak of, but furnished with a pair of big eyes close beside the tiny snout. They are languid, boneless, worm-like creatures, very gelatinous in substance, and looking much like pellucid eels without the skin on. For a long time these leptocephali (as they are called) were supposed to be a peculiar class of fishes, but they are now known to be young fry of various shore-haunting kinds, which have drifted out into the open ocean, and had their development permanently arrested for want of the natural environment. They are in fact fish idiots, and though they grow in size they never attain real maturity. If, as some authorities believe, many of these queer idiotic forms really represent stray flat-fish, then their symmetrical development once more points back to the happy days when the ancestral sole still swam upright, with one eye on each side of his head, instead of being distorted into a sort of aggravated squinter.

Besides the "reversed" specimens of soles and turbots—right-sided when they ought to be left-sided, and *vice versa*—occasional double or ambidextrous individuals occur, in which the dark color is equally developed on both sides of the body. Whether these impartial flat-fish are in the habit of turning over in their beds—whether they represent the uneasy sleepers of pleuronectid circles or otherwise—I am not in a position to state; but probably they are produced under circumstances where both sides have been frequently exposed to the action of light, which seems to have a sort of photographic effect upon the pigments of the fish's body. Everybody knows in fact that the upper side or back of most ordinary fish, exposed as it is to the sunlight, is darker than the lower side or belly; and this natural result of the solar rays has indirectly a protective effect, because when you look down into the water from above it appears dark, whereas when you look up from below the surface appears bright and shining; so that a fish is less

likely to be observed (and eaten) if his back is dark and his under-surface white and silvery.

Albino soles are far rarer than doubles, and seldom occur except in very young and foolish specimens. Naturally an albino forms an exceptionally sure mark for his enemies to hawk at, and he is therefore usually devoured at an early stage of his unhappy existence, before he has time to develop properly into a good specimen. For the same reason adult white rabbits are very rare in the wild state, because they form such excellent targets for owls in their early infancy. Rabbits, when tamed, as we all know, tend to "sport" in color to a surprising extent ; but this tendency is repressed in the wild condition by the selective action of the common owl, which promptly picks off every rabbit that does not harmonize well in the dusk of evening with the bracken and furze among whose stalks it feeds.

All the flat-fish are carnivorous. They live chiefly off cockles and other mollusks, off lugs, and lob-worms, or off small shrimp-like creatures and other crustaceans. In summer-time soles resort to banks and shallow spots near the mouths of rivers to deposit their spawn. They are obliged to do this in shallow waters, because, like most other fish, they are very unnatural mothers, and leave the sun to do the whole work of hatching for them. To be sure, there are some few right-minded fish which take a proper view of their parental responsibilities, such as the pipe-fishes, which carry about their unhatched eggs in a bag, sometimes borne by the affectionate mother, but oftener still by the good father, a perfect model to his human *confrères.* Or again, the familiar little stickleback, who builds a regular nest for the reception of the spawn, and positively sits upon it like a hen, at the same time waving his fins vigorously backward and forward so as to keep up a good supply of oxygen. But soles and most other fish consider that their parental duties are quite at an end as soon as they have deposited their spawn in safety on a convenient sunny shallow.

This fact produces a sort of annual migration among the soles and other flat-fish. In spring, when all nature is beginning to wake up from its winter sleep, the soles seek the shoal water, which forms their spawning-ground ; and, therefore, in April, May, June, and July, the British sole is chiefly trolled for off the Dogger Bank and the other great submerged flats of the North Sea. But when November comes on again the soles once more retire for the season into winter quarters in the deep water for the purpose of hibernating during the foodless period. The North Sea soles (in whose habits and manners the London public is most profoundly interested) generally resort for their long snooze to a deep depression known as the Silver Pits, lying close beside the Dogger Bank. These Silver Pits are so called because when they were first discovered (about the year 1843) they formed a sort of Big Bonanza for the lucky fishermen who originally resorted to them. There the soles lay, huddled together for the sake of warmth,

like herrings in a barrel, thousands and thousands of them, one on top of the other, a solid mass of living and sleeping solehood, only waiting for the adventurous fisherman to pull them up and take them to market. Man, treacherous man, crept upon their peaceful slumber unawares, and proceeded, like Macbeth, to murder sleep wholesale in the most unjustifiable and relentless manner. He dropped his lines into the Silver Pits—the water there is too deep for dredging—and hauled up the hapless drowsy creatures literally by the thousand till he had half exhausted the accumulated progeny of ages. The Silver Pits are still excellent winter fishing-grounds, but never again will they yield such immense fortunes as they did at the moment of their first exploration.

In 1848, when the California gold-fever was at its very height, some other lucky smack-owners hit upon a second deposit of solid soles, lying in layers on a small tract of coarse bottom near Flamborough Head, where they retired to hibernate, perhaps, in consequence of the hard treatment they had received in the Silver Pits. This new El Dorado of the fishing industry was appropriately nicknamed California, because it proved for the time being a very mine of gold to its fortunate discoverers. But, like the prototypal California on the Pacific coast, its natural wealth was soon exhausted ; and, though it still yields a fair proportion of fish, its golden days are now fairly over.

Driven from the banks and pits by their incessant enemy, the trawler, the poor soles have now taken to depositing their spawn on the rough, rocky ground where the fishermen dare not follow them for fear of breaking their nets against the jagged ledges. These rocky spots are known as sanctuaries, and if it were not for them it is highly probable that sole *au gratin* would soon become an extinct animal on our London dinner-tables. Even to the sanctuaries, however, they are rudely followed, as Professor Huxley has shown, by their hereditary fishy foes, who eat the spawn, and so deprive the world of myriads upon myriads of unborn soles, consigned before their time to dull oblivion. Formerly, fishermen used to throw away these useless fish when caught ; in future, they have strict orders from the inspectors of fisheries to kill them all wherever found.

However, even the remnant left by all enemies put together is quite sufficient to repeople the waters with a pleuronectid population with extraordinary rapidity. The fecundity of fish is indeed something almost incredible. The eggs of soles are extremely small—not so big as a grain of mustard-seed—and the roe of a one-pound fish usually contains as many as one hundred and thirty-four thousand of them. Turbot are even more surprisingly prolific : Frank Buckland was acquainted with one whose roe weighed five pounds nine ounces, and contained no less than fourteen million and odd eggs. It is a sad reflection that not more than one of these, on an average, ever lives to reach maturity. For if only two survived in

each case the number of turbot in the sea next year would be double what it is this; the year after that there would be four times as many; the next year eight times again; and so on in a regular arithmetical progression. In a very few decades the whole sea would become one living mass of solid turbot. As a matter of fact, since the number of individuals in any given species remains on the average exactly constant, we may lay it down as a general rule that only two young usually survive to maturity out of all those born or laid by a single pair of parents. All the rest are simply produced in order to provide for the necessary loss in infant mortality. The turbot lays fourteen million eggs, well knowing that thirteen million nine hundred and ninety-nine thousand nine hundred and ninety-nine will be eaten up in the state of spawn or devoured by enemies in helpless infancy, or drifted out to sea and hopelessly lost, or otherwise somehow unaccounted for. The fewer the casualties to which a race is exposed the smaller the number of eggs or young which it needs to produce in order to cover the necessary losses.

In fish generally it takes at least a hundred thousand eggs each year to keep up the average of the species. In frogs and other amphibians, a few hundred are amply sufficient. Reptiles often lay only a much smaller number. In birds, which hatch their own eggs and feed their young, from ten to two eggs per annum are quite sufficient to replenish the earth. Among mammals, three or four at a birth is a rare number, and many of the larger sorts produce one calf or foal at a time only. In the human race at large, a total of five or six children for each married couple during a whole lifetime makes up sufficiently for infant mortality and all other sources of loss, though among utter savages a far higher rate is usually necessary. In England, an average of four and a half children to each family suffices to keep the population stationary; above that number it begins to increase, and has to find an outlet in emigration. If every family had four children, and every child grew up to maturity and married, the population would exactly double in every generation. Even making allowances for necessary deaths and celibacy, however, I believe that as sanitation improves and needless infant mortality is done away with, the human race will finally come to a state of equilibrium with an average of three children to each household. But this is getting very far away indeed from the habits of flat-fishes.—*Cornhill Magazine.*

SKETCH OF FRANCIS GALTON.

A SKETCH of Francis Galton may appear with manifest fitness in the same number of the "Monthly" in which is published an abstract review of M. de Candolle's researches into heredity and the other conditions favorable to the production of men of science. Mr.

Galton is also a painstaking and intelligent investigator of the operations of heredity; he has made special studies of the family histories of English men of science; and presents in himself a bright example of the hereditary transmission of intellectual gifts.

FRANCIS GALTON is a grandson of Dr. Erasmus Darwin, the famous author of "Zoönomia," and a cousin of the illustrious author of the "Origin of Species." He is the third and youngest son of S. T. Galton, of Duddeston, near Birmingham, and was born in 1822. He received his preparatory education at King Edward's School near Birmingham; studied medicine at the Birmingham Hospital and King's College, London; and was graduated at Trinity College, Cambridge, in 1844. He afterward made two journeys in Africa, the first of which, begun in 1846, was in the northern part of the continent and on the White Nile, through regions which were then rarely visited; and the second in the western regions of South Africa, on which he started from Walfish Bay in 1850. Among the fruits of this journey was the book, "Narrative of an Explorer in Tropical South Africa." He also received, on account of it, the gold medal of the Royal Geographical Society, of which he has since been an active member and efficient officer. He published in 1855 a book on the "Art of Travel, or Shifts and Contrivances in Wild Countries," which has gone through numerous editions, and still holds its place in the markets. His "Meteorographica," published in 1863, was the first attempt to represent in charts on a large scale the progress of the elements of the weather. From his studies in connection with the preparation of this work was developed the theory of anti-cylones, which was first propounded by him. A committee of the Board of Trade having been appointed, after the death of Admiral Fitzroy in 1865, to examine into the past and future duties and administration of the Meteorological Office, Mr. Galton was placed upon it at the instance of the Royal Society. He is now a member of the Council, to whose hands the parliamentary grant for the maintenance of the Meteorological Office is intrusted.

Mr. Galton is best known by his researches, which have been many, varied, and valuable. His journeys, and the books which he based upon them, stamp him a geographical explorer of no low or mediocre rank. His work in the Meteorological Office has been sufficient in itself to give him a high and extensive reputation. But all that he has done in these two branches has been surpassed, and we might say obscured, by his later researches in the laws of heredity and the growth of genius, and in anthropological measurements. Appertaining to Mr. Galton's studies on heredity are his paper on Pangenesis, read before the Royal Society in March, 1871, in which he drew, from his experiments on the transfusion of blood in rabbits and their after-breeding, conclusions adverse to Mr. Darwin's theory on that subject, and which became the topic of a correspondence between Mr. Darwin, himself, and Dr. Beale in the columns of "Nature"; his researches into

the laws of blood-relationship, communicated in a paper to the Royal Society in June, 1872; and the inquiries which are represented in his books on "Hereditary Genius, its Laws and Consequences" (1869); "English Men of Science; their Nature and Nurture" (1874); and "Inquiries into Human Faculty and its Development" (1883).

In the lecture on "Blood-Relationship" he sought to analyze and describe the complicated relation that binds an individual, hereditarily, to his parents and to his brothers, and therefore, by an extension of similar links, to his more distant kinsfolk. By these means he hoped to set forth the doctrines of heredity in a more orderly and explicit manner than was otherwise practicable. "From the well-known circumstance," he said, "that an individual may transmit to his descendants ancestral qualities which he does not himself possess, we are assured that they could not have been altogether destroyed in him, but must have maintained their existence in a latent form. Therefore each individual may properly be conceived as consisting of two parts, one of which is latent and only known to us by its effects on his posterity, while the other is patent and constitutes the person manifest to our senses. The adjacent, and, in a broad sense, separate lines of growth in which the patent and latent elements are situated, diverge from a common group and converge to a common contribution, because they were both evolved out of elements contained in a structureless ovum, and they jointly contribute the elements which form the structureless ova of their offspring. . . . The observed facts of reversion enable us to prove that the latent elements must be greatly more varied than those that are personal or patent." An elaboration of this view, and a more detailed examination of the phenomena caused the author "to be impressed with the fallacy of reckoning inheritance in the usual way, from parents to offspring, using those words in their popular sense of visible personalities. The span of the true hereditary link connects, not the parent with the offspring, but the primary elements of the two, such as they existed in the newly impregnated ova whence they were respectively developed." In conclusion, he recorded as one result of the investigation, a very clear showing that "large variation in individuals from their parents is not incompatible with the strict doctrine of heredity, but is a consequence of it wherever the breed is impure. I am desirous of applying these considerations to the intellectual and moral gifts of the human race, which is more mongrelized than that of any other domesticated animal. It has been thought by some that the fact of children showing marked individual variation in ability from that of their parents is a proof that intellectual and moral gifts are not strictly transmitted by inheritance. My arguments lead to exactly the opposite result. I show that their great individual variation is a necessity under present conditions, and I maintain that results derived from large averages are all that can be required, and all we could expect to obtain, to prove that intellectual and moral

gifts are as strictly matters of inheritance as any purely physical qualities."

In 1874 Mr. Galton published his "English Men of Science; their Nature and Nurture." It was a summary of the results which he had obtained from inquiries addressed to the most eminent scientific men of England, respecting the hereditary and other circumstances which might have been influential in directing them toward the careers in which they shone, and promoting their success in them. His criterion, in selecting men as typical for his purpose, was somewhat like that which M. de Candolle adopted. He took persons who had been elected to the Royal Society, and of them those who had been otherwise distinguished by receiving medals, or by holding official positions in scientific bodies or professorships in some important college or university. One hundred and eighty men were questioned for facts concerning their parentage and descent, the religious opinions, occupations, political party, health, stature, complexion, temperament, size of head, and a great many other particular facts concerning their parents and themselves; regarding their brothers and sisters, and their salient characteristics; the numbers and principal achievements of more distant relatives, grandparents, uncles and aunts, cousins, nephews and nieces; and the mode and duration of the education of the questioned scientific man himself, with an analysis of the causes of success of which he was conscious.

From the replies to these inquiries it appeared that the chief qualities in the order of their prevalence among scientific men were, energy, both of body and mind; good health; great independence of character; tenacity of purpose; practical business habits; and strong innate tastes for science generally, or for some branch of it.

The replies respecting the special experience in education of the men addressed exhibited a striking unanimity, notwithstanding the diversity of branches of science which they severally pursued. They commonly expressed a hatred of grammar and the classics, and an utter distaste for the old-fashioned system of education. "The following seems the programme they themselves would have most liked: 1. Mathematics, rigorously taught up to their capacity, and copiously illustrated and applied, so as to throw as much interest into its pursuit as possible; 2. Logic; 3. Some branch of science (observation, theory, and experiment), some boys taking one branch and some another, to insure variety of interests under the same roof; 4. Accurate drawing of objects connected with that branch of science; 5. Mechanical handiwork. All these to be rigorously taught. The following not to be taught rigorously: reading good books (not trashy ones) in literature, history, and art; a moderate knowledge of the more useful languages, taught in the easiest way, probably by going abroad in vacations. It is abundantly evident that the leading men of science have not been made by much or regular teaching. They craved

variety. Those who had it, praised it; and those who had it not, concurred in regretting it. There were none who had the old-fashioned high-and-dry education who were satisfied with it. Those who came from the greater schools usually did nothing there, and have abused the system heartily."

In 1877, as Vice-President of the Anthropological Department of the British Association, Mr. Galton described a method of accurately measuring mental processes, such as sensation, volition, the formation of elementary judgments, and the estimation of numbers; suggested means, by the aid of photography, of studying the physiognomy of the criminal and other special classes of men; and discussed the subject of heredity in crime. In the address in which these thoughts were conveyed he suggested that there were no worthier professors of the branch of anthropology that relates to types of character "than the writers of the higher works of fiction, who are ever on the watch to discriminate varieties of character, and who have the art of describing them. It would, I think, be a valuable service to anthropology if some person well versed in literature were to compile a volume of extracts from novels and plays that should illustrate the prevalent types of human character and temperament." Carrying out the ideas of this address to a further extent, he discussed, in a paper read before the Anthropological Institute in 1878, the system of taking composite portraits, by combining the portraits of several individuals distinguished by possessing some common quality into a single portrait which might be considered as typical of that quality personified. As among the possible practical applications of this system, he suggested that "it might be used to give typical pictures of different races of men; to construct a really good likeness of a living person by the combination of several likenesses of the ordinary sort; to produce, from many independent portraits of an historical personage, the most probable likeness of him; and, lastly, an application of great interest in inquiries into the hereditary transmission of features."

Among the later investigations of Mr. Galton is an interesting one on "Visualized Numerals," regarding a faculty which very many persons have been proved to possess, of forming, when any number is mentioned or thought of, vivid conceptions of the figures constituting the number as projected before them or standing plainly out in the air.

Since 1875 Mr. Galton has been engaged in active investigations, with the Anthropometric Committee of the British Association, of the heights, weights, etc., of human beings in the British Empire, and in obtaining photographic representations of the typical races.

Mr. Galton was General Secretary of the British Association from 1863 to 1868; was President of its Geographical Section in 1862 and 1872, of the Anthropological Sub-section in 1877, and of the Anthropological Section in 1885; and he has been Vice-President of the Royal Geographical and Anthropological Societies, and a member of the councils of many other bodies.

CORRESPONDENCE.

DOES THE FLYING-FISH FLY?

Messrs. Editors:

PROFESSOR MÖBIUS says, in "The Popular Science Monthly" for December, that "flying-fish are incapable of flying, for the simple reason that the muscles of their pectoral fins are not large enough to bear the weight of their body aloft in the air."

If they are incapable of flying, then they do not fly; so there's the end on't. But, if they really do fly, they are capable of flying; and the argument is as good in this case as in that. In both we must look to the facts.

Passing out of the harbor of San Pedro one day, the steamer came into a school of fish. Being the first I had ever seen, I watched them with great interest. Their flight was often several hundred feet—farther than a strong man can throw a stone—describing a gentle curve at its highest part only a few feet above the water. The velocity was nearly uniform, gently accelerated for a few seconds after leaving the water, and correspondingly retarded before entering it again..

Now, every one of these facts is inconsistent with the single-impulse hypothesis. It is simply impossible that a fish could acquire under water, or just at leaving it, a velocity that could carry it so far after passing into the air. The resistance of water against a body moving rapidly is so great that a bullet soon spends its force when passing into it. To suppose that a fish could strike the water with its fins with such force as to carry it several hundred feet in the air, is to suppose an unsupposable case; and certainly to refute the charge that "the muscles of their pectoral fins are not large enough" for flight. A stone thrown from the hand describes a parabolic curve. The fish moves nearly horizontally. The initial impulse must be immensely greater that could carry it, without any apparent falling, several hundred feet—so great that no strength of muscle could be equal to it. Again, the resistance of the air can not be inconsiderable, and the velocity of flight, if acquired from a single impulse, should be retarded from the moment of leaving the water; but, as before stated, the contrary is true. It does not always move in a straight line; but this could be true on either hypothesis, the fish using the tail-fin as a rudder. The distance of flight, the nearly horizonal line described, and the nearly uniform velocity, would be simply impossible on the single-impulse hypothesis, but are entirely consistent with the supposition that the fish actually flies.

The pectoral fins of the flying-fish are very large, and shaped like the wings of a bird. Their motion, while in the air, is that of flying, not of mere fluttering.

Possibly the above facts may be of some use in settling the reputation of the flying-fish. ISAAC KINLEY.

LOS ANGELES, CALIFORNIA.

THE INTERPRETATION OF GENESIS.

Messrs. Editors:

PUBLIC attention having been largely drawn to Professor Huxley's article on "The Interpreters of Genesis and the Interpreters of Nature" (republished in "The Popular Science Monthly" for February), I ask the privilege of saying a few words, in reply to that portion of his paper which particularly interests believers in the Bible. No doubt but he is right as to the order of life set forth by Mr. Gladstone. I think, too, he is justified, at least to some extent, in his protest against the readiness of "reconcilers" to change their explanations, and to force new meanings on the Hebrew to meet the exigencies of science.

After his protest, Professor Huxley turns from Mr. Gladstone to what he supposes to be the story in Genesis. Of course, we turn to our Bibles to see for ourselves. I think every opponent of revelation will agree that it is fair to try the story, not by what others have said, but by its own words. And I would propose as a sufficiently severe working hypothesis the following rule of interpretation: *The story means what it says. We shall not add to it nor take from it, and its words shall be taken each in its ordinary sense as determined by lexicon and grammar.* As a corollary, I add, the account is not responsible for what its friends or foes have said it says—unless it be found there; and that omission is not denial. This rule seems rigid enough to remove the reproach of Professor Huxley in his New York lecture—"One can but admire the flexibility of the Hebrew language." The third proposition of Professor Huxley's paper, "the central idea of this story, the maintenance of which is vital, and its refutation fatal," that on which they—the theologians—"are surely prepared to make a last stand," is this: "The animal species which compose the water-population, the air-population, and the land-population, originated during three distinct and succes-

sive periods of time, and only during these periods of time."

Although Professor Huxley does not speak of vegetation, yet, undoubtedly, he would include it also in his statement, and therefore I venture to bring that, too, into the discussion, and add, in accordance with his central idea: The species which compose the present vegetable kingdom originated in one distinct period of time preceding the three animal populations, and only in that one period of time.

As this "central idea" certainly has no existence in science, the only question of interest is: Does it exist in Genesis; or is it an interpolation of Professor Huxley's; or, rather, is it an unfounded tradition which he has too readily adopted? I read in Genesis i that at a certain time the earth "brought forth grass, the herb yielding seed, and the fruit-tree bearing fruit whose seed is in it."* Professor Huxley's central idea adds, "And there were no plants before these." The first is true, the last is false.

Again, I read that at a certain time the waters swarmed with water-creatures, among which were "whales," and every kind of moving creature, which the waters brought forth abundantly, and fowls that were to fly in the air. That is all, and it is true. But Professor Huxley's central idea adds, "And before whales and fowl there was no form of animal life," an addition which is false.

Further on I read that, subsequent to the plants and animals named, the earth brought forth cattle, beasts, and creeping things. This also is true. Professor Huxley's "central idea" adds, "And before them there were no land-animals of any kind." Another falsehood.

Where the account is simply silent, Professor Huxley fills the hiatus, and then says, in substance: How unworthy of scientific notice; how false—three statements in a few lines, important ones too, which every geologist knows are not true! It is clear that the story is a myth.

It may be said—True, Moses does describe modern species, but here is where his error lies. He intended to describe the beginning of organic life, and, instead, has described only the latest. If so, he built more wisely than he knew. Intending to state what geologists now know would have been false, he has, in fact, stated what they know to be true. It seems to me that his intention was to say that all things were made by God, and, looking around on the universe, he names what he saw—the heavens, the light, the firmament, the land and seas, the sun, moon, and stars, the vegetable and animal world then in existence. These, or rather their coming into being, he names in a certain order. All, save the last two, are not mentioned in Professor Huxley's article, but they are the basis of his indictment; it is therefore eminently proper to see what are the facts of our world's history pertaining to the advent of life, and how they accord with the three statements in Genesis.

"The following propositions"—I quote from Professor Huxley's tenth "Lay Sermon"—"are regarded by the mass of paleontologists as expressing some of the best-established results of paleontology":

"Animals and plants began their existence together, and these succeeded each other in such a manner that totally distinct faunæ and floræ occupied the whole surface of the earth, one after the other, and during distinct epochs of time.

"A geological fauna or flora is the sum of all the species of animals or plants which occupied the surface of the globe during one of the epochs."

I add: a geological horizon* is the sum of all the species of plants and animals of one of those epochs. There were many horizons—as many as epochs. Professor Dana makes upward of fifty ("Manual of Geology," pp. 142, 143). I note a few which are of peculiar importance, either in themselves or in relation to this account.

In the earliest are found traces of marine plants only, and of the lowest forms of animal life (an Archæan horizon).

In another, perhaps a million years later, radiates, mollusks, and articulates are found, while sea-weeds are the highest type of plants.

Another million or so of years brings us to the Upper Silurian, where are found a few land-plants, but among them no fruit-trees.

Another vast stretch brings a Devonian horizon, with more land-plants, but no such flora as Moses describes. There were fishes, but neither "whales" nor "fowl."

Long after this came the Carboniferous period, with water-animals and land-animals, and an abundant flora. Still, there were no fruit-trees, nor were there whales in the seas or cattle on the land.

Later, again, in the Tertiary, we find a flora exactly answering to that in Genesis, containing, as it does, grasses, herbs, and fruit-trees with the seed in the fruit—i. e., angiosperms, including in that term palms. As to the animals of this horizon, there were then fishes, birds, and mammals, but not of living species. Professor Dana, ("Manual of Geology," revised edition, page 518), says, "All the fishes, birds, reptiles, and mammals of the Tertiary are extinct." These, therefore, were not the fauna of

* Revised Version says, v. 12: "And the earth brought forth grass, herb yielding seed after its kind and tree bearing fruit, wherein is the seed thereof after its kind."

* "On the same horizon" is said of the fossils and strata of one age.—"Imperial Dictionary."

which Moses wrote as "living creatures." But still later, in the Quaternary, there were fishes, amphibians or reptiles, mammals and birds, whales and seals. Most of the birds are still represented. Some, however, have died out very recently, say within a century or less. Of the others, save the mammals, all kinds, so far as known, are still in existence. The mammals are nearly all extinct.*

At this time, therefore, the marine life and the "fowl" of to-day came into existence. I note here a circumstance that is in remarkable harmony with the well-known fact that many species of invertebrates, and perhaps some others, have come down from the Tertiary. There is the fiat that the waters were to swarm with living creatures, and then, in the next verse, an assertion of creatorship so broad as to include every living creature—as if it said God "created," through his way of doing such things, all that appeared for the first at that time, as well as all else then living.

Coming still further down in the world's history, we reach the horizon of to-day, with its living species of land-animals, including cattle, beasts, and creeping things. The remark about the previous horizon applies here also.

I submit, therefore, as the result of an examination of the Mosaic record, that Professor Huxley's "central idea" has no existence in Genesis if taken without "flexibility" or additions; and, it appears to me that, according to geology, the story as told in Genesis is true as to its order. A flora containing fruit-trees did come before the living air and water population; and these came before living cattle and beasts.

As to all other matters pertaining to life the account is silent, but silence is not falsehood.

In the limited space of a letter I have been able to give but scant justice to my theme.

Other important questions press upon me. What about man? What is the true "central idea"? What about the rest of the chapter; will it bear this intensely literal treatment? And the "days," are they days or periods?

I can but hint at answers, and that only to two of the questions. Paleontology tells very little about man. Genesis says only that God made a pair whom he called Adam.† There may have been older races. Such seem to be referred to when Cain says he is afraid that whoever meets him will kill him; and so where the account speaks of the sons of God and the daughters of men.

The true "central idea" is God's creatorship. This might have been given in one sentence, or have been extended into particulars, and these particulars might have been given in any order, or, if the author was wise enough to be able to do it, the particular acts of creatorship might have been named in the order of their occurrence. As there are, on a close analysis, some forty matters of order or fact in this story, it is impossible that by any chance or guess they should fall into the true order. But what if they are there? As to the "days," I suppose that they were twenty-four hours long, and that creation was millions of years in being accomplished. The paradox is, as it seems to me, easily explained, but to attempt it now, or to give my reasons for believing the order identical with that revealed by science, would extend this letter beyond its due limits. Yours truly,

C. B. Warring.

Poughkeepsie, N. Y., *March* 21, 1886.

* Page 345. Nicholson's "Ancient Life History": "No extinct forms of fishes, amphibians, or reptiles are known to occur." Also Dana. "Manual of Geology," third edition, p. 563: "The mammals are nearly all extinct."

† Or man, according to the margin of the Revised Version.

ANTIDOTES FOR SNAKE-POISON.

Messrs. Editors:

In "The Popular Science Monthly" for May, 1885, I read with great interest an address by Professor William W. Keen, M. D., in the course of which he mentioned Drs. Weir Mitchell and Reichert, of Philadelphia, as being engaged in experiments on the venom of the cobra and rattlesnake. At that time I decided to send you the account of an incident which might furnish a clew to a proper antidote for this venom; but a protracted illness in my family has hitherto prevented the carrying out of this intention. I am now in a position to do so, and shall therefore proceed at once to the narrative of the incident in question.

In the summer of 1883, while engaged in some field-work in Polonio Pass, San Luis Obispo County, California, a young "setter" dog, belonging to a comrade, was bitten on the nose by a rattlesnake. The dog suffered for a few days, but did not die. However, from a sprightly and intelligent animal, he became transformed into a sickly and stupid one. He became emaciated and miserable, and his vision was greatly impaired—in fact, all of his faculties seemed to be benumbed.

Shortly afterward we went up into the Sacramento River Cañon, and took this dog, together with a host of others (the usual concomitants of an engineer's camp), with us to our new field of labor. Now, in the late autumn the banks of the upper Sacramento River become annually lined with the decaying bodies of large numbers of "dog" sal-

mon—salmon that have died from exhaustion while endeavoring to force themselves to the head-waters of the river for spawning purposes; and in the fall of 1883 our canine camp-followers partook voraciously of this free salmon-feast, with the result that all of them, with one single exception, died—with every indication of being poisoned. The single exception was the young dog that had suffered from the rattlesnake-bite. He apparently experienced no discomfort from his meal; and, strangest of all, from that day he became a well dog! He regained his youthful elasticity of spirit, became robust, and, when I last saw him, was as playful and intelligent a dog as I have ever seen. There is no exaggeration in any of these lines, and what I have here stated can be verified by at least a dozen witnesses.

To my mind this incident seems to point to the conclusion that there is developed in salmon, and possibly in other decaying fish, an organic principle, in itself poisonous, but which may prove to be a counter-agent for the poison of the rattlesnake and of other venomous serpents. I am therefore inclined to believe that an examination of this matter might result in the production of an antidote to the terrible venom of the poisonous snakes; and, in the hope that such may be the case, I remain, respectfully yours,

Bernard Bienenfeld.

1018 Post Street, San Francisco, *November* 29, 1885.

EDITOR'S TABLE.

CHARITY AND SENTIMENTALITY.

AN apostle once wrote, "Let love be without dissimulation." Had he lived in our day, he might have thought it quite as important to say, "Let love be without sentimentality." In looking over the reports of charitable institutions—especially purely voluntary ones—we are frequently struck by the utter absence of any attempt to deal in what might be called a scientific manner with the facts that come within their scope. Instead of this, we have any amount of sentimentality and gush, pious ascriptions of thanks to Providence, considerable laudation of the officers engaged in the work of the institution, and long lists of donations, with the names of the donors, of course. Now, we would cheerfully exchange all this for a little information likely to be servicable in a scientific point of view. Say it is an "orphans' home." What we should like to know in connection with the operations of such an institution may be roughly indicated under the following heads: 1. In regard to each inmate, whether he or she is really an orphan or not. 2. If so, how the condition of orphanage and dependence arose. 3. How it happened that private aid from friends or relatives was not forthcoming—whether, for example, the existence of a convenient asylum into which the orphan could be put had anything to do with the child's being placed there rather than otherwise provided for. 4. What moral effects seem to flow from the absence of parental affection and influence. 5. What the special influences of the home or asylum seem to be in different classes of cases. 6. What the subsequent course in life of children released from the home has been.

It is too much the habit of the present day to think that, if things are done from a right motive, they must be done well. One evil effect of this is to discourage criticism of motives apparently good; yet the interests of society as a whole call for nothing more strongly than for a stringent criticism of motives as well as of actions. Take the case of our orphan asylum again. In some small town, a lot of benevolent people, chiefly of the more emotional sex, will decide that an orphan asylum is wanted. There may be only three or four cases within their knowledge at the time that in any way call for such an institution; and probably no very great amount of private effort would be required to dispose of these satisfactorily in a private way.

Still, the idea of an orphan asylum, managed by a society of ladies, is a very taking one. It will make room for a lady president, two or three lady vice-presidents, a lady secretary, a managing committee of ladies, and, of course, lady visitors. So the asylum is ushered into existence. Though modest in its beginnings, it is still beyond the real wants of the locality. The few known orphans are gathered in; and then the ladies, hungry for objects of benevolence, look round for more; rather than have empty rooms and a half-employed matron, they "rope in," on one pretext or another, children who are not orphans at all. Then they challenge public attention by annual reports and annual collections. Of course, every man in the community who wants to be credited with even a fragment of a soul must subscribe to the orphan asylum. It would be as much as one's social existence was worth to so much as hint a doubt as to whether an institution with a name so redolent of charity was really performing a useful office in the community. So the funds come in freely. The ladies, finding how prompt is the response to their benevolent appeals, conceive large and daring schemes. They are going to have a building now that will be a credit to the town, and that will not only rob orphanage of half its terrors, but widely advertise the willingness of the community to shoulder everybody's private burdens in the matter of children needing protection through the loss of parents. So a ridiculously large building goes up, to the infinite pride and satisfaction of the lady managers, and the silent wonderment of the meditative citizen with a gift for arithmetic and averages, but perhaps no experience as to how the orphan business like other businesses can be "boomed."

Now, the hard, bottom fact is, that fuss and vanity enter very largely into many of these schemes of so-called charity. They reek with sentimentality; and therefore it is no wonder that those who work them content themselves with reports at once jejune and nauseating—jejune in facts, nauseating in phraseology. The best possible way to check these flabby imitations of real charity would be to summon them somewhat peremptorily to give such facts as might furnish material for a really scientific study of their operations. They could not in decency refuse the demand, if made by a certain number of their respectable supporters; and yet we are convinced that, to comply with the demand in anything like an honest and thorough fashion, would be to show that their work was, in part at least, hollow and even hurtful. We believe that a vast amount of harm is being done, not only by thoughtless private charity, but by ill-organized, ill-directed, and over-ambitious corporate charity. However, let scientific thinkers, men who have taken to heart all that is implied in the great truth that two and two make four, settle right down to work on the reports of some of these pretentious concerns; and, where they find information lacking that ought to be given, quietly ask for it. The world would be none the worse for the puncturing of a few of the bubbles blown by vanity and floated by sentimentality; and the way to puncture them is to bring the "scientific method" to bear on their very unscientific operations.

We are glad to see that the views expressed in these columns a year ago, in regard to the inexpediency of giving Federal aid to education in the South or anywhere else, are gaining ground among the most intelligent representatives of public opinion. The "Boston Herald," one of the most progressive papers in the country, which at one time favored the scheme, now opposes it. There is altogether too strong a disposition in certain quarters to bring the Federal Government into play for

the redress of all kinds of wrongs. The ideal should rather be to reduce its functions to the narrowest limits in order that all the more life may reside in our local institutions, and all the more scope be left to private initiative. It is easier to stereotype a civilization than people imagine, and the way to do it is to look to the Government for everything.

To show how easy it is to make a fallacious use of figures, we may mention that in the alarming statistics frequently published in support of the Blair Bill for Federal aid to education in the South—statistics intended to show what an overwhelming mass of ignorance existed in the Southern States—no account was taken of the fact that a very large proportion of the illiterate blacks belonged to a class—the adult population—whom educational measures could never reach, however liberal might be the appropriations made therefor. A recent writer has pointed out that when we come to compare the percentage of children attending school in the South with the percentage so attending, say, in New England, the difference is by no means very striking. The South is evidently doing well, and will yet do better, if no intrusive and demoralizing aid is afforded to it out of the national treasury.

LITERARY NOTICES.

Three Years of Arctic Service. An Account of the Lady Franklin Bay Expedition of 1881–'84, and the Attainment of the Farthest North. By Adolphus W. Greely. New York: Charles Scribner's Sons. Two vols. Pp. xxv–428, and 444, with Maps.

No story of tragic adventure has ever excited greater interest or invoked stronger sympathy than that of the life and sufferings of Lieutenant Greely and his party of twenty-four men at Cape Sabine during the winter of 1883–'84. Other parties have suffered intense privations and pains, in the Arctic regions and other inhospitable parts of the globe; but, as a rule, there have been features of some kind to set off and relieve the uniformity of their misery, or else, all having perished, the world has escaped the sorrow of viewing the picture of their suffering in photographic detail. But with this party of our countrymen there were nine months of monotonous uniformity of suffering, and slow, steady progress toward death; and enough have survived its perils to describe the pains in all their colors. It is right that we should have this full story of the expedition from its commander. He was responsible for its management, and he was the member of it, if any, who was best able to take a complete view of it as a whole, and in all its aspects. In preparing his account, he has, he says, spared neither health nor strength. For materials he has drawn upon his own diary, the official field reports, and the journals of Lieutenant Lockwood and Sergeant Brainard, the only complete ones, with his own, that were kept. As is fitting, the story of the last terrible days of starvation, freezing, and death, is told almost wholly in the words of the diaries as it was recorded from day to day at the time, with hardly a word of comment.

The expedition commanded by Lieutenant Greely was intended to establish one of the international stations for circumpolar observation that had been decided upon after the suggestion of Lieutenant Weyprecht, of the Austrian Navy, by the Polar Conferences which met in Hamburg and Berne in 1879 and 1880. Two of the fourteen stations established were assigned to the United States—one at Point Barrow, in latitude 71° 18′ north, longitude 156° 24′ west, under Lieutenant Ray, and one at Lady Franklin Bay, latitude 81° 44′ north, longitude 64° 45′ west, under Lieutenant Greely. The station at the latter point, when established, was named Fort Conger, after Senator Conger, of Michigan, who had interested himself specially in behalf of the expedition. Hardly had the party landed, when a defect in its organization revealed itself, in the shape of inharmonious elements and the want of strong enough authority. The circumstance, says Lieutenant Greely, emphasizes "the necessity of selecting for Arctic service only men and officers of thoroughly military qualities, among which subordination is by no means of sec-

ondary importance." Our wonder is that the thought of a plan of selection from which this was omitted should have been tolerated for an instant. The primary object of the expedition being to carry out the scientific programme of the Hamburg Polar Conference, the utmost care was given to physical observations. The series began July 1, 1881, at St. John's, Newfoundland, and terminated June 21, 1884, forty hours before the rescue of the survivors. Summaries of them are given in the appendixes to the book, and a chapter is allotted to the description of the manner in which they were taken. Natural history observations and collections were also made, but the collections, of course, in the straits to which the expedition was reduced, could not be brought home. As good provisions as were possible under the circumstances were, however, made for the preservation of the scientific results. They were *cachéd*, at places which were suitably marked and described, and may possibly be recovered by more fortunate adventurers. A suggestive glimpse of the character of Arctic life during the winter darkness is afforded by the fact that some of the observations and the places for taking them were arranged so as to afford the men reasonable occasions, in going to mark them, for going out-of-doors and taking walks of considerable length. Exercise is as indispensable in the winter of the poles as in more favored regions, and one of the difficult problems for explorers is to manage matters or "sugar-coat" it, so that it shall be taken regularly and in sufficient amount without appearing to be administered as a medicine.

Two important geographical achievements stand to the credit of the expedition: They are the journey of Lieutenant Lockwood, Sergeant Brainard, and the Eskimo Christiansen to the farthest north, and the exploration of Grinnell Land. The itinerary of the northerly journey, as given from the journals of the explorers, is very interesting, and, with the aid of the accompanying maps, is very clear. It was on the 13th of May, 1882, when, having made sixteen miles in ten hours, and worn out by travel through deep snow, the party made their farthest camp at the north end of Lockwood Island, which, by circum-meridian and subpolar observations reduced by Gauss's method, was determined to be in 83° 23·8′ north, the highest latitude ever attained by man. The highest latitude reached previous to this was by Markham, on sea, in 1876, 83° 20′ 26″. Of this event Sergeant Brainard's field-notes say: "We have reached a higher latitude than ever before reached by mortal man, and on a land farther north than by many was supposed to exist. We unfurled the glorious Stars and Stripes to the exhilarating northern breezes with an exultation impossible to describe." So, says Lieutenant Greely, "with proper pride, they looked that day from their farthest vantage-ground of the farthest north (Lockwood Island) to the desolate cape which, until surpassed in coming ages, may well bear the grand name of Washington." Of this party Sergeant Brainard, "without whose efficient aid and restless energy, as Lockwood said, the work could not have been accomplished," is the only survivor. The exploration of Grinnell Land begun by Lieutenant Greely in the spring, whose journey of two hundred and fifty miles of travel in twelve days was marked by the discovery of the large Lake Hazen and the interesting Henrietta Nesmith Glacier, was continued in the summer with the results, as summed up by the author, of the satisfactory, if not complete, determination of the extent of North Grinnell Land; the outlining of the extraordinary and previously unsuspected physical conditions of the interior of that country; and the discovery of numerous valleys covered with comparatively luxuriant vegetation, which afford sufficient pasturage for large numbers of musk-oxen. About five thousand square miles of newly discovered land fell under observation, of which over one half was determined with sufficient accuracy to enable its physical geography to be passed upon. Lieutenant Greely's discoveries accord closely with the opinions of Sir Joseph Hooker; and "the intimate relation between the physical sciences is forcibly illustrated by the ability of a highly trained and accomplished specialist to state from a handful of plants the insularity or continental configuration of a land and its physical condition." Another expedition was made, across Grinnell Land, by Lieutenant Lockwood, who carried out his commander's in-

structions to their full extent, although he started under the belief that they could not be accomplished.

Lieutenant Greely has his views of the constitution of the polar regions, and they are entitled to all the respect which the opinions of a man of intelligence who has had unusual opportunities for observation have a right to command. He does not doubt "that in the vicinity of the north and south poles are glacial lands entirely covered by ice-caps of enormous thickness, which throw off the huge floebergs of the north and the yet more remarkable flat-topped icebergs of the south. The north polar land is, I believe, of limited extent, and its shores, or the edges of its glaciers, are washed by a sea which, from its size and consequent high temperature, its ceaseless tides and strong currents, can never be entirely ice-clad. . . . Far be it from me to advocate a navigable polar sea. On the contrary, I am firmly possessed with the idea that an ice-belt from fifty to a hundred miles wide borders the lands to the southward, and that the water-space to the northward can only be entered in extremely favorable years by the Spitzbergen route."

We had marked many passages illustrative of the monotonous life of the Arctic winters and its depressing and irritating effect upon the minds of the men; descriptive of the toilsome journey from Camp Conger to Cape Sabine, and of the attempt to cross Smith Sound; and incidents of the unprecedented sufferings of the party in their spring of cold starvation at Cape Sabine; but we have no space for them. The story, moreover, is not one that can be represented by incidents selected here and there, but should be taken in a whole. The headings of the closing chapters fittingly suggest its character. They are: "The Beginning of the End"; "The Last of Our Rations"; "The End—by Death and Rescue." Of the whole, Lieutenant Greely says: "No pen could convey to the world an adequate idea of the abject misery and extreme wretchedness to which we were reduced at Cape Sabine. Insufficiently clothed, for months without drinking water, destitute of warmth, our sleeping-bags frozen to the ground, our walls, roof, and floor covered with frost and ice, subsisting on *one fifth* of an Arctic ration, almost without clothing, light, heat, or food, yet we were never without courage, faith, and hope. The extraordinary spirit of loyalty, patience, charity, and self-denial—daily and almost universally exhibited by our famished and nearly maddened party—must be read between the lines in the account of our daily life penned under such desperate and untoward circumstances."

Easy Lessons in German. By Adolphe Dreyspring. New York: D. Appleton & Co. Pp. 103. Price, 70 cents.

The "Easy Lessons" is intended as an introduction to the author's "Cumulative Method," and to be adapted both to schools and to home instruction. It is designed not only for those who shun "full-grown" text-books, and to whom price is a material consideration, but more especially for the boys and girls of the primary classes, to whose intellectual status it is better adapted than are the larger works. The aid of illustrations is freely called in to enforce the meaning of the nouns and verbs, so that each of the conventional lessons into which the work is divided is in fact a series of object-lessons. We regard the author's system, which consists of frequent repetition and the putting of the word or set of words, which is the particular subject of the lesson, through its varieties of combinations and changes, as an excellent one. The exercises are conversational, are made interesting and amusing, and are so directly to the point they are designed to enforce, that by the time the pupil is through with one of them, it is well impressed upon his mind, and not likely to be forgotten.

The Determination of Rock-forming Minerals. By Dr. Eugen Hussak. Authorized Translation from the German, by Erastus G. Smith, Ph. D. New York: John Wiley & Sons. Pp. 233. Price, $3.

This book is intended to supply a want long felt by students of mineralogy and lithology. It presents, in a shape adapted for use in the class-room and the laboratory, a digest of numerous articles bearing upon the subject, that have appeared in technical journals and other publications of various countries.

The first part of the work treats of the

methods of investigation adopted in mineralogical and petrographical research; the optical methods and the micro-chemical methods are considered in turn.

The second part is devoted to the study of mineral determination. A table for determining the system of crystallization of the rock-forming minerals is followed by a most elaborate set of tables which give the composition and chemical reactions of the minerals, their structure, association, etc.

A great number of illustrations are scattered through the book, and a feature that will prove most welcome is the bibliography to Part II, which contains references to many works on mineralogy, and to numerous memoirs that have been published in scientific periodicals.

History of the Pacific States of North America. By Hubert Howe Bancroft. Vol. XXVIII. Alaska, 1730-1885. San Francisco: A. L. Bancroft & Co. Pp. 775. Price, $5.

Alaska furnishes materials for a more varied and interesting history than any one would imagine before reading this volume. The story is really full of incident and adventure, and is graphically presented. The early history of Alaska, as the publishers well remark, is wholly different from the history of any other part of America. It dates from a different quarter of the globe; the territory was seized and occupied by a people who never mingled in American affairs before or since. "For reckless courage, for indifference to suffering and death, for cruelty and iniquity, the Russians were in no wise behind the Spaniards. And the character and customs of the Russians themselves are no less objects of interest than those of the natives of Alaska, which, for the most part, are unlike those of other American aboriginal peoples. The Russian fur-trade, as it was in the beginning, the century march of the Cossacks across Siberia, the voyages of discovery to the opposite coast of America, and the fur-hunting expeditions which followed, are all full of thrilling interest." Of the importance of Alaska the author has a much better opinion than generally prevails, and observes that "Scandinavia, her Old-World counterpart, is possessed of far less natural wealth, and is far less grand in natural configuration. In Alaska we can count more than eleven hundred islands in a single group. We can trace the second largest water-course in the world. We have large sections of territory where the average yearly temperature is higher than that of Stockholm or Christiania, where it is milder in winter, and where the fall of rain and snow is less than in the southern portion of Scandinavia." And the area of this part of the territory is greater than that of Scotland and Southern Scandinavia combined. The resources, also, of Alaska, "though some of them are not yet available, are abundant, and of such a nature that, if properly economized, they will never be seriously impaired." To procure material for this history, Mr. Bancroft dispatched an agent well acquainted with its affairs, on three distinct journeys to Alaska, who visited all places of historical importance and persons of historical note, and thus obtained much fresh information; explored, by his assistants, documentary material in Sitka, San Francisco, and Washington; was aided by his friend M. Pinart, and men of letters and officers in St. Petersburg, in collecting information from the Russian archives; and obtained all the accessible authorities in print in Russia, other European countries, and the United States. This volume has the distinction from the others of being the first of the series which is complete in itself, with preface, and index from the beginning of the history to the present day.

Practical and Analytical Chemistry. By Henry Trimble, Ph. G. Philadelphia: P. Blakiston, Son & Co. Pp. 94. Price, $1.50.

This book is intended for the use of students of medicine, pharmacy, and others who may have but a comparatively limited amount of time to devote to the study of chemistry. Part I, "Practical Chemistry," discusses briefly the preparation and properties of gases and the preparation of salts; Part II treats of "Qualitative Analysis"; Part III of "Quantitative Analysis." The former contains some reference to the reactions of organic compounds, the latter embraces examples for practice in both gravimetric and volumetric estimation.

Evolution of To-Day: A Summary of the Theory of Evolution as held by Scientists at the Present Time, and an Account of the Progress made by the Discussions and Investigations of a Quarter of a Century. By H. W. Conn, Ph. D., Instructor of Biology at Wesleyan University. New York: G. P. Putnam's Sons. Pp. 342. Price $1.75.

The greater evolution of ideas precipitated with such unparalleled rapidity during the last generation by the promulgation of the general doctrine of evolution and the wide-spread interest in the subject which has followed have brought us, as was inevitable, to a stage of popular literature upon the question which shows plenty of signs that it is no longer the scientific world that is chiefly addressed. The number of those who think themselves competent to explain evolution to ordinary people is largely increasing, but, while their efforts are undoubtedly commendable, it must be admitted that much of their work is inferior and unsatisfactory. The subject itself is extensive, complex, and unsettled, and it requires a good deal of sound information, careful habits of thinking, and excellent scientific judgment, so to present it as not to convey to uninstructed minds about as much error as truth.

The present volume, although not without merit, belongs nevertheless to this unsatisfactory class of books upon evolution. In the first place, the title is mischievously misleading. It would lead us to expect a discussion of the subject in its full breadth and latest developments and applications; whereas it is confined, we might almost say, strictly to one branch of the subject—organic evolution; and the book might much better be named a treatise on Darwinism than an exposition of the evolution of to-day. While dealing with the details of biological development, Dr. Conn writes with tolerable clearness; but when he tries to expound the fundamental conceptions of his volume, as presented in its title, he writes neither clearly nor correctly, and betrays considerable confusion of mind over the larger relations of his subject. In his introduction, Dr. Conn says: "*Evolution is not Darwinism.* We have now reached the conclusion as to what is now ordinarily meant by evolution" (derivation of species by descent, Ed.), "and such was Darwin's understanding of the term. But it must not be confounded with Darwinism. Evolution is simply a theory as to the method by which species have been introduced into the world, entirely independent of any idea as to the causes which have brought about their introduction. Darwinism is evolution, but it is more than this; it is at the same time an attempt at an explanation of the causes of evolution.'' Again, he says, "Darwinism proper, then, is not evolution, but its explanation."

Now, these views are probably original with Dr. Conn; at any rate, we have never met them before, and they are certainly far from representing the "evolution of to-day." Evolution, as now most generally held, is a law of Nature—a law of transformation by which phenomena undergo changes, passing from one form to another, by which the past has given rise to the present, and the present determines the future through the agencies of the natural world. Evolution is a phase of the order of Nature of great comprehensiveness, or it is nothing; it has its large divisions, of which organic evolution is one. Mr. Darwin devoted himself to the study of one of the elements or factors of organic evolution—the origin of species by means of natural selection. To define evolution as excluding the study of causes, and then to define Darwinism as a study of causes, or as explanation of evolution, is simply absurd. As a matter of science, evolution is essentially, and indeed solely, a problem of forces and causes, and Mr. Darwin did what he could to trace them out in the line of his special work; but he never made even an attempt to study the theory of evolution as a general law of Nature, to analyze, formulate, or reduce it to scientific expression.

The Sun. By Amédée Guillemin. Translated from the French, by A. L. Phipson. New York: Charles Scribner's Sons. Pp. 297. Price, $1.

This book forms one of a series termed "The Illustrated Library of Wonders," of which Messrs. Charles Scribner's Sons are now publishing a new and revised edition. Inviting his readers to join him in a little trip of the imagination—a trifle of some

ninety million miles or thereabout—the author discourses pleasantly on that luminous sphere that forms the destination of this astronomical journey.

The sun is considered as the source of light, of heat, and of chemical action; its influence on living beings, on animals and plants, is commented upon. The position of the sun in the planetary world, its rotation, its physical and chemical constitution, are all studied in turn; and, finally, there are given the reasons why life is, must be, impossible upon its surface. Numerous illustrations are scattered throughout the text.

History of California. By Theodore H. Hittell. San Francisco: Occidental Publishing Company. Pp. 799. Price, $5.

The author of this history is a well-known legal writer of California, who has spent many years of industrious labor in its preparation. His purpose has been to give an account, and, at the same time, a picturesque history of the State, a popular history, adapted to the use of those who have not time to read a larger work, but who desire at the same time a comprehensive review of the subject, in which every branch is treated in due proportion to its relative importance as viewed with regard to the whole. No other State, the publishers claim, possesses so romantic a history as California, and in no work on the subject that we have observed has more effort been made with greater success to present it in a way which, while it does not lack in the essential point of accuracy, shall make the story interesting and pleasant in the reading. Beginning with the very first account of the country found in the older records, it traces the development, illustrates the progress, and shows how, step by step, the State became what it is. The old voyages, with their interesting incidents; the heroic tale of the early settlements; the labors of the missionaries, and their establishment of the missions; the lives and acts of the Spanish and American governors; the changes wrought in the condition of the country by the revolution against Spain and Spanish ideas; the growth of the civil as opposed to the ecclesiastical, and the popular as opposed to the monarchical power; the struggles of individuals and factions; and the evolution of the new State, are related in a plain, engaging style. In the present volume the first book is devoted to the stories of the early voyagers; the second book covers the period of the Jesuit mission settlements of Lower California, and closes with an account of the Indians of that region; the third book covers the period of the Franciscan missions and the beginnings of Alta California; and the other books include the history of the Spanish governors, the Northwest coast fur-trade, later Northwest coast-voyages and discoveries, overland expeditions and explorations, and the Indians of Alta California. The second volume, which will complete the work, is promised soon.

A Text-Book of Inorganic Chemistry. By Professor V. von Richter. Authorized Translation, by Edgar F. Smith, Ph. D. Philadelphia: P. Blakiston, Son & Co. Pp. 423. Illustrated. Price, $2.

The fact alone that this volume bears the imprint, "Second American from the fourth German edition," would seem to bespeak for this work a degree of merit not common to many of the numerous productions that have appeared in this field of science. A careful examination of its pages confirms this impression. Usually text-books on this subject present but a more or less complete enumeration of *facts*. The different elements are considered in turn: their occurrence, modes of preparation, properties, important compounds, etc., are discussed; but little effort is made to point out the theories deduced from the observations and experiments.

In this work, however, the inductive method is followed throughout. Experiments are given and carried out, with the intention of drawing conclusions from them, and of illustrating the close relation between the results obtained and the theories founded upon them.

The introduction briefly defines the province of chemistry, refers to the principle of the indestructibility of matter, the conservation of energy, chemical energy, conditions of chemical action, chemical symbols and formulæ. The elements are classified according to the law of periodicity, this meaning simply that the properties of the

elements and their compounds present themselves as a periodic function of their atomic weights.

Attention must also be directed to another feature of this book, as important as it is novel in a text-book on inorganic chemistry. When bodies enter into chemical combination, heat is almost invariably evolved; and, on the other hand, when a compound is decomposed into its constituents, heat is absorbed and transformed into chemical energy. The study of these phenomena, thermo-chemistry, is here introduced in connection with the different groups of the elements, thus familiarizing the student from the start with one of the fundamental principles of chemical science, yet one which has heretofore been almost entirely relegated to works on theoretical chemistry. In short, Von Richter offers a most clear, vivid, and interesting presentation of his subject.

Van Nostrand's Science Series. Ventilation of Buildings. By W. F. Butler. Re-edited and enlarged, by James L. Greenleaf, C. E. Pp. 147.

Water-Meters. By Ross E. Browne. Pp. 89.

The Preservation of Timber by the Use of Antiseptics. By S. B. Boulton. Pp. 223.

Mechanical Integrators; including the Various Forms of Planimeters. By Professor Henry S. H. Shaw. Pp. 212. Price, 50 cents each.

Ventilation of Buildings.—This essay was originally prepared for delivery before an audience, which will account for the fact that it contains remarks and comments on subjects which can hardly be considered as specially connected with the ventilation of buildings, though in themselves of interest and importance. It was written for English conditions, and the present copy has been re-edited and enlarged by Mr. Greenleaf to adapt it for use in this country. The needs for ventilation are first discussed, and then a method is given for ventilating private houses, showing how this method may be adapted to old and to new buildings. Appended to the book is a reprint from "Van Nostrand's Magazine" on "How much Ventilation?" by the editor of this issue.

Water-Meters.—A brief treatise on some of the principal forms of water-meters in use, embracing descriptions of the prominent features of two forms of piston-meter, the Worthington and the Kennedy, and three forms of velocity-meters, the Siemens of English manufacture, the Siemens of German manufacture, and the Hesse meter. A series of tests conducted with the latter is given. An appendix contains a translation of an article on some forms of water-meters not considered in the text previous. This article is by Charles André and was published in the "Génie Civil." The book is intended mainly for hydraulic engineers.

The Preservation of Timber by the Use of Antiseptics.—A paper prepared for the Institution of Civil Engineers and discussed before them; the discussion is appended. It is a careful review of the history of preserving timber, and the chief methods adapted to that end.

Mechanical Integrators.—Descriptions of various devices that may be designated as mechanical aids to mathematical computation; chiefly such are considered as will prove of value to engineers.

Chemical Analysis for Schools and Science Classes. Qualitative-Inorganic. By A. H. Scott-White, B. Sc. New York: Scribner & Welford. Pp. 130.

A concise text-book intended in the first place for students fitting for examinations at English colleges. Valuable hints are given as to the preliminary analysis, then follow schemes of examination for bases and for acids, and appended are notes on apparatus, on the preparation of reagents, etc. A quite extensive list of the chemical symbols of substances made use of in the analytical work is given. These symbols are arranged in alphabetical order, and, as the corresponding names are also given, will prove very convenient for the student.

First Lessons in Philosophy. By M. S. Handley. New York: Scribner & Welford. Pp. 59.

A brief presentation, in the form of conversations, of the elementary conceptions of philosophy. This book is intended to serve as an introduction to metaphysics and logic. It is essentially based on the writings of S. H. Hodgson, principally on "Time and Space," by this author.

Chemical Equilibrium the Result of the Dissipation of Energy. By G. D. Liveing, M. A., F. R. S. New York: Scribner & Welford.

This essay presents the substance of a course of lectures delivered by the author in the University of Cambridge. The doctrine of the dissipation of energy is, that "there is a universal tendency in nature for energy to take such forms and to be so distributed that it is not available to do mechanical work." This theory is here considered in a form especially adapted to the problems of chemistry, and will prove of interest to students of chemical philosophy.

Moisture and Dryness; or, the Analysis of Atmospheric Humidities in the United States. By Charles Denison, A. M., M. D. Chicago: Rand, McNally & Co. Pp. 30, with Charts. Price, $1.

An essay read before the American Climatological Association, and reprinted from "The New York Medical Journal" for September, 1884. The author takes the position that "an actually small amount of atmospheric moisture is the most important element in the best climates for phthisis." The causes affecting dryness, i. e., temperature, altitude, the seasons, etc., are considered; tables of Signal-Service stations in the United States, rated in order of dryness, are given; and, finally, the physical effects of dryness are discussed.

PUBLICATIONS RECEIVED.

Pennsylvania Boroughs. By William P. Holcombe. Baltimore: N. Murray. Pp. 51. 50 cents.

Bulletin of the Philosophical Society of Washington. Vol. VIII, 1885. Washington: Smithsonian Institution. Pp. 110. 75 cents.

Forests and Fruit-Growers. By Abbot Kinney, Los Angeles, California. Pp. 5.

Eczema. By George H. Rohé, M. D. Baltimore: Thomas & Evans. Pp. 46.

Bulletin of the Scientific Laboratories of Denison University. Edited by C. L. Herrick, Granville, Ohio. Pp. 136, with Tables and Plates.

American Society of Microscopists. Eighth Annual Meeting, August, 1885: Proceedings. D. S. Kellicot, Secretary. Buffalo, N. Y. Pp. 258, with Plates.

Reflex Irritation from Hypertrophy of Labia Minora. By Charles L. Gwyn, M. D., Galveston, Texas. Pp. 7.

Gyrating Bodies. An Empirical Study. By C. B. Warring. Ph. D., Poughkeepsie, N. Y. Pp. 106, with Plates.

The Physics and Metaphysics of Money. By Rodmond Gibbons. New York: G. P. Putnam's Sons. Pp. 34. 25 cents.

On the Nutritive Value of some Beef Extracts. By Thomas J. Mays, M. D. Philadelphia. Pp. 12.

The Influence of Sewerage and Water-Supply on the Death-Rate in Cities. By Erwin F. Smith, Ann Arbor, Mich. Pp. 84, with Plates.

International Electrical Exhibition, 1884; Reports on Educational Apparatus and Apparatus for High Electro-Motive Force. Pp. 56. Meteorological and other Registers. Pp. 13. Philadelphia.

Ottawa Field Naturalists' Club. Transactions, No. 6. 1884, 1885. F. R. Latchford, Ottawa, Canada. Pp. 140, with Plates.

Montreal Botanic Garden. First Annual Report. D. P. Penhallow, Director. Pp. 31.

The Processes of Electrotyping and Stereotyping. Boston: H. C. Whitcomb & Co. Pp. 24.

Report of the Agricultural Experiment Station at Amherst, Mass., for 1885. O. B. Hadwen, Secretary. Pp. 141.

The Sphingidæ of New England. By C. H. Fernald, Orono, Me. Pp. 87, with Plates.

Food Consumption, etc. By Carroll D. Wright. With Chemical Analysis and Treatment by Professor W. O. Atwater, Middletown, Conn. Pp. 70.

The Economic Fact-Book and Free-Traders' Guide. Edited by R. R. Bowker. New York Free-Trade Club, 39 Nassau Street. Pp. 151. 25 cents.

Passaic, New Jersey, and its Advantages as a Place of Residence and as a Manufacturing Center. By William H. Gillen. Pp. 48.

List of the Aphididæ of Minnesota. By O. W. Oestlund, University of Minnesota. Pp. 56.

Double Congenital Displacement of the Hip. By Buckminster Brown, M. D. Boston: Cupples, Upham & Co. Pp. 24, with Plates.

Notes giving a Cause for the Present Dull Times. By Frederic Grimm, San Francisco. Pp. 96.

Quarterly Report of the Bureau of Statistics, Treasury Department, to December 31, 1885. Washington: Government Printing-Office. Pp. 100.

The Topographic Features of Lake Shores. By Grove K. Gilbert. Washington: Government Printing-Office. Pp. 121, with Plates.

The Monthly Index. Q. P. Index, Bangor, Me. Monthly, folio page. 25 cents a year.

Taxation of Mutual Life Insurance. By Jacob L. Greene. Pp. 10.

The Half-Breed—Vita sine Literis. By John Reade. Montreal: Dawson Brothers. Pp. 38.

The Social Emancipation of the Gipsies. By James Simson. New York: Thomas R. Knox & Co. Pp. 30. 25 cents.

Electric Lighting: Its Present Condition. By N. H. Schilling, Ph. D. Boston: Cupples, Upham & Co. Pp. 55.

Scouring of Wool in Belgium, Great Britain, and Germany. Consular Reports. Washington: Government Printing-Office Pp. 8, with Plates.

Dutch Village Communities on the Hudson River. By Irving Elting. Baltimore: N. Murray. Pp. 68. 50 cents.

Town Government in Rhode Island. By William E. Foster. The Narragansett Planters. By Edward Channing. Baltimore: N. Murray. Pp. 36 and 23. 50 cents.

Fish Remains and Tracks in the Triassic Rocks at Weehawken, New Jersey. By L. P. Gratacap. Pp. 4.

Destruction of our Native Birds. Committee Report, American Ornithologists' Union. Pp. 16.

Les Crânes dits deformes. (Skulls called deformed.) By Juan Ignacio de Armas, Havana. Pp. 16.

On the Inequalities of Wealth. By an American. New York: Theo. Berendsohn. Pp. 15. 10 cents.

What is Medicine? By Albert L. Gihon, M. D. Pp. 28.

Discussion of a Paper on the South Pass Jetties. By James B. Eads. Pp. 48.

Chicago Manual Training-School. Third Annual Catalogue. Pp. 16.

Notes on the Literature of Explosives. No. IX. By Professor Charles E. Monroe, U. S. N. A., Annapolis, Md. Pp. 13.

Studies of Rhythm. By Professor G. Stanley Hall and Joseph Jastrow, Johns Hopkins University. Pp. 8.

Labor Differences and their Settlement. By Joseph D. Weeks. New York: Society for Political Education, 31 Park Row. Pp. 79. 25 cents.

Torpedoes for National Defense. By William H. Jaques. U. S. Navy. New York: G. P. Putnam's Sons. Pp. 49. 25 cents.

New Theories concerning the Nervous Elements. By Thomas Powell, M. D., Paola, Kan. 1 sheet page.

Municipal Administration. By Robert Mathews, Rochester, N. Y.

Official Register of Physicians and Midwives in Illinois. Springfield, Ill.: State Board of Health. Pp. 314.

New Fresh-Water Sponges from Nova Scotia and Newfoundland. Two papers. By A. H. McKay, Canada. Pp. 4 and pp. 8.

How shall the Erie Canal be improved? By the Hon. Horatio Seymour, Jr. New York Board of Trade and Transportation, 55 Liberty Street. Pp. 8.

Appalachia. March, 1886. Pp. 188. 50 cents. Register of the Appalachian Mountain Club, for 1886. Pp. 40. Boston: W. B. Clarke and Carruth.

The Fonetic Herald for 1885, Port Hope, Can. A. Hamilton. Pp. 40. Monthly. 25 cents a year.

The Path. Edited by William Q. Judge. New York: Aryan Theosophical Society, A. H. Gebhard, Publisher. Monthly. Pp. 32. $2 a year.

The Skeleton in Geococcyx. By R. W. Shufeldt. Pp. 12, with Plates.

The Distribution of Rainfall in New England, February 10 to 14, 1886. By Winslow Upton. Pp. 6, with Plates.

History of the Appointing Power of the President. By Lucy M. Salmon. New York: G. P. Putnam's Sons. Pp. 129. $1.

Cassell's National Library. No. 6, "The Rivals" and "School for Scandal." Pp 189. No. 8, "Plutarch's Lives of Alexander the Great and Julius Cæsar." Pp. 192. No. 9, "The Castle of Otranto," by Horace Walpole. Pp. 191. "The Voyage and Travels of Sir John Mandeville, Kt." Pp. 192. 10 cents each.

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POPULAR MISCELLANY.

Glacial Elevations of the New England Coast.—Professor N. S. Shaler, in the course of his studies to investigate the origin of *kames* or "Indian ridges," which are particularly abundant and characteristic along the New England sea-coast south of Portland, Maine, has been led to the conclusion that the glacial submergence along this coast was much greater than is commonly assumed. Very distinct cross-bedded sands in extensive sheets occur at points as much as one hundred and seventy feet above high tide, in positions where, owing to the contour of the ground, one can not believe that they were formed in any inclosed basin of fresh water. They are found at Randolph Station, on the Old Colony Railway, and about Attleboro, Massachusetts, at heights of from one hundred and ninety to two hundred feet. These deposits were clearly distributed by tidal action, and, as we must suppose that the water lay to the depth of fifty feet or so above the place of the deposit, there must have been something like two hundred feet of depression along this shore where the glacier left it. Between this level and the present shore-line the *kames* are plentifully scattered. In consideration of their delicate structure and sharp

outlines and other features, it is difficult to see how they escaped the cutting action of the sea-beach that must have been dragged over all of this surface as it was emerging from the sea. A single month of exposure to such waves as act even in the more sheltered bays would entirely destroy their more delicate outlines. After a careful examination of the evidence, Mr. Shaler has been driven to suppose that at the close of the glacial period the re-elevation of the land must have been accomplished with a very great suddenness.

The Genesis of Inventions.—In a paper read before the Anthropological Society of Washington, on "The Genesis of Inventions," Mr. Franklin A. Seely proposes the term Eunematics to designate the study of invention. He lays down, as fundamental postulates of this science, that, given any artificial implement or product, we must assume that there was a time when it did not exist; that before it existed there must have been a creature capable of producing it; and that such creature before producing it must have been conscious of needing it, or must have had use for it. Further, that every human invention has sprung from some prior invention or from some prior known expedient; that inventions always generate wants, and these wants generate other inventions; that the invention of tools and implements proceeds by specialization; and that no art makes progress alone. The last four of these propositions are verifiable from the history of any and of all modern inventions; the three former are deduced, and must be confirmed, if they need confirming, by the study of prehistoric inventions. In illustration of their force, Mr. Seely produces a theoretical study of the invention of the stone hatchet, a tool which represents the earliest human workmanship of which any knowledge has come to us, and presents in its rudest form the evidences of being the fruit of long-antecedent growth. When men used wooden poles for pikes, they found that their weapons were better if they were pointed. One man found that he could point pikes by rubbing them back and forth on a certain gritty stone he had. Other men brought their pikes to him to be sharpened. Then they found that they could sharpen them themselves on other stones. The sharp edge of a cliff was found to be particularly good for this purpose, and, when it was rubbed dull, another cliff-edge was looked out. Then, by some accident, the dulled cliff-edge was broken off, and a new edge, possibly even sharper than the old natural edge, was presented. The step was not long from this discovery to designedly breaking off cliff-edges. Then some one discovered that the broken piece, fixed so as to be steady, or held in the hands, would also cut. When the stick-sharpener found that he could hold the stick firmly and trim it by passing over it the sharp stone held in the hand, he had a flint knife. Another series of experiments led to inserting the sharp stone into a handle, and another series to the differentiation of stones of different shapes and sizes for various purposes. Parallel with these processes were those of the development of cords for tying, from the first accidental shred of bark to fabricated strings of twisted bark or cut strips of hide.

Parental Peculiarities in Fishes and Frogs.—Fish and frogs are not usually regarded as very careful parents, but a few species exercise something like a particular care for their young. Sticklebacks build nests for the reception of the eggs, and the males watch them and defend them against intruders. The males of sea-horses (*Hippocampi*) and pipe-fishes are provided with pouches in the under side of the body, reminding us of those of the opossum, in which the eggs are put after having been cast by the female, and are cared for till they are developed. These pouches seem also to be a kind of home for the young. The female of the genus *Solenostoma* also has a pouch, formed by the union of the ventral fins with the body, in which the eggs are laid and hatched, and this is furnished with a series of long, thread-like bodies bearing small projections, for the attachment of the eggs, and possibly for the nutrition of the young. The skin and tissues of the under-body of the mother *Aspredo*, when the egg-laying season comes round, assumes a soft, spongy texture, to which the eggs adhere till they are hatched, when the skin becomes smooth again. The

male of the *Arins* of Ceylon and the *Chionais* of the Sea of Galilee carry the eggs in the back part of the mouth. The eggs of dog-fishes, sharks, skates, and rays are inclosed in capsules which in texture resemble a bit of sea-weed. The mother-frog of the *Alytes obstetricans* lays her eggs in long chains of sixty or more. The male takes this string, twines it around his thighs, and retires till the young are ready to leave the egg; then he goes into the water, and the young swim out. The eggs of the American frogs are placed in pouches in the back of the mother, and in the Surinam toad the egg and the tadpole go through their full development thus inclosed, each in its own cell, till, when they emerge, they differ only in size from the parent. More than one hundred and twenty of these tadpole-cells have been counted in the back of a single female of this species. A Chilian frog has the organs, corresponding with the "vocal sacs" of our bull-frogs greatly distended, and the young are hatched in these. The exaggeration of these organs has produced more or less of distortion in other parts of the animal.

Happy Tenant-Farmers.—A writer in "Chambers's Journal" holds up Lord Tollemache, of Peckforton Castle, Cheshire, as a landlord who has found a plan of dealing with his tenants that satisfies his farmers, his laborers, and himself, and which is working with encouraging results. This proprietor set out to establish cottage-farms upon his estate, for the purpose of attaining three results: To satisfy the natural and praiseworthy desire of the laborers to have a cow, and land to maintain it; to train the rising generation of laborers' children from infancy in dairying and agricultural pursuits; and to secure a supply of high-class laborers for his large tenant-farmers. All of these results are in process of accomplishment. The cottage-farms consist of house-inclosures—the houses being built in pairs and fitted with conveniences—of about half a rood of garden-land each, with a tract attached, including pasture, of about three acres, and are leased at a fixed rent of fifty dollars a year, for twenty-one years. The laborers thus housed are declared markedly superior to those of their class in most counties. "Their wives are robust, their children are unusually intelligent, and the social atmosphere of the neighborhood is exhilarating. In every house visited the furniture was good and excellently cared for. Neatness and cleanliness were evidently habitual. . . . And it is the proud boast of the neighborhood that the laborers on the Tollemache estates are unexcelled in England." As a consequence of this system, "while dread and perplexity pervade the shires, the happy dwellers upon Lord Tollemache's estate are at peace. Every large farm is occupied, and the obtaining of one is the great object of those living outside."

Automatic Fire-Extinguishers.—Professor Silvanus P. Thompson, in a recent address before the Society of Arts, dwelt upon the fact that great fires usually owe their magnitude and their consequent terrors to the circumstance that a certain interval of time necessarily elapses before any application is made to extinguish them—because no one is at hand and ready to act on the instant. It is to the fatal two minutes or five minutes that pass before help arrives, that the mischief is due. Nothing but a self-acting or automatic system, which will operate at the right moment and at the very spot, without the intervention of the human hand, will meet the case. Automatic systems exist, and are of several kinds, and efficient. Automatic sprinklers are self-acting valves connected with a system of water-pipes placed in the ceiling of a room, which, on the outbreak of a fire, open and distribute water in a shower or spray exactly at the place where the fire breaks out. The apparatus may be arranged so that, whenever it is called into operation by the heat, it shall sound an alarm-bell and summon aid to the spot. These devices are relied upon in many of the manufacturing establishments of New England, with an estimated reduction of the risk of conflagration to one twentieth of what it formerly was. Several designs for sprinklers depend for their efficacy on the melting of some kind of easily fusible solder or cement by the heat of the incipient fire, and the consequent loosening of the valve which holds the water back. The obvious requi-

sites of a good sprinkler are that the solder should fuse at a low and well-defined temperature, without any appreciable prior softening; that the mechanism should not be liable to get out of order or stick; that the parts opened by heat should be capable of ready replacement without skilled labor; that there should be no leakage at the valve; and that the quantity of solder to be melted should be small, and so placed that it is not cooled by contact with too great a mass of metal, or exposed to the drip of the opening valve. Closely allied to the automatic sprinkler proper is the system of sprinkling by perforated pipes through an automatic valve. The automatic fire-door, which should not be of iron, because it curls up, but of wood protected by sheathings of tin-plate, is arranged to shut on an inclined track, and is kept open by a rod made with a scarf-joint in two parts twisted in the center, and secured by a fusible solder; or the door may be held by a cord holding a weight, the fall of which releases the door; the fall to be produced by the melting of a solder set in some convenient part of the cord. Another class of devices depends upon the introduction into the electric circuit of a fusible link, the melting of which breaks the circuit; or into the broken circuit of a strained catgut band, the contraction of which by the heat brings the wires into contact. In one of the applications of this system a reservoir of carbonic acid is opened and the acid distributed. Mr. Jolin has invented an arrangement for making the hand grenade extinguisher automatic. He proposes to hang the grenade at the top of a room in a sort of a cage, which is provided with a small button held together with fusible alloy. When that is affected by the ascending hot air, the button bursts, and the cage opens and allows the grenade to fall, while an iron weight follows it, and, breaking it in mid-air, causes the liquid to be sprinkled about.

Parasitic Fungi on Plants.—Professor T. J. Burrill, in a paper of the Illinois State Laboratory of Natural History on the parasitic fungi of the State, remarks with reference to the nature of these pests, that "during the last part of the first half of this century learned discussions arose upon the specific distinction between the parasite and the host, and esteemed botanists held the view that what was taken for the former was but a diseased condition of the latter—the rust of wheat, for example, was only the degraded cell-tissues of the wheat itself. Such difference of opinion, however, no longer exists among those who have possession of the information now acquired. The tissues of higher plants do not change by any process of degradation or transformation into the things called fungi, neither do the latter originate in any other manner than as descendants of pre-existing forms through as rigid specific lines as can be traced among any animals or plants. It is known, too, that however much the fungus is found within the tissues of the host-plant, it began its growth outside of the latter, and gained introduction only by forcible entrance. Spores are never taken up by absorption and carried by the aqueous currents from part to part of the plant. The fungus passes through the tissues very much as roots pass through soil, sometimes apparently without in any degree successful opposition, sometimes nearly or quite baffled in the struggle by the mechanical and physiological resistances of the host-plant."

The Punjab.—The Punjab derives its name—which means "five waters"—from the five great rivers traversing it—the Jhelum, Chenab, Ravi, Béas, and Sutlej—which, united, flow into the Indus about five hundred miles above its mouth. In early times the country was called the land of the "seven rivers," and the Indus itself, on the one side, and the Saraswati, on the other side, were counted in addition to the five streams already named. The Saraswati, according to General R. Maclagan, presents an interesting problem. All the other rivers of the seven take their rise in the snows of lofty mountains, and, being fed from unfailing sources, are always great streams; but the Saraswati rises in the low outer hills, depends on periodical rains only, and, while subject to floods, is dry for a great part of the year. Even in the flood season, the water with which its upper valley is inundated runs off so quickly that it all disappears before it can reach the Sutlej or the Indus. Yet in the ancient Indian writings

it is described as a mighty river like the others. The name, which means "having running water," seems to mark it as a constant as well as powerful stream, and is applied as an epithet to the Indus and other great rivers. The volume of the stream may have been partly affected by the changes which the country in general has undergone, but a considerable part of the discrepancy must be attributed to the poetic character of the Vedas and the imperfect knowledge which the Sanskrit people may have possessed of the character of this river. In the later writing, dating from about the sixth century B. C., the Saraswati is said to sink into the earth and to pass underground to join the Ganges and the Jumna at their confluence. The people had then gone farther into the country, and had become better acquainted with the Saraswati.

Influence of Direct Solar Heat on Vegetation.—Mr. M. Buysman has published a paper on the "Influence of Direct Sunlight on Vegetation." On account of the constant high temperature in the tropical regions, plants there are less dependent on direct solar heat than in the temperate and frigid zones, but there are some even there which require this condition for their luxuriant growth. Among these are the date-palm and the sugar-cane. In the warm temperate zone, the orange grows best in the direct sunlight, and the vine requires the heat of after-summer to ripen its fruits. Everywhere, whether in the warm or temperate region, corn is grown with success wherever there is in summer direct sunlight enough to ripen its grains. On highlands, the influence of insolation is very much increased. But the solar warmth of the after-summer is necessary to ripen the fruits of the most important plants; and it is for lack of this, and not from any deficiency in the mean temperature, that the vine can not be cultivated successfully in cloudy England. The limit of corn cultivation ascends on the continent generally farther to the north than on the shores. In Norway, it reaches 70°; at Fort Norman, Canada, 65°; at Yakutsk, Siberia, 62°; on the northeast shores of Asia and the northeastern shores of America, nearly to 50°; on the western shores of America, 57°. Nowhere else is the influence of insolation more distinctly observed than in the Arctic regions. Richardson remarks, of the vicinity of Slave River, near 60° north latitude, that he had never felt the heat of the tropics so oppressive as he experienced it on some occasions in those regions, though the sun's rays are there always horizontal instead of vertical, as is the case in the tropical countries. This is because in summer the sun rests above the horizon. In Nova Zembla the vegetation is, in places exposed to the sun's rays, "like an arctic flower-garden," for the surface of the soil is not covered with grass as in the temperate regions; and the flowers are of a much greater size than the leaves. In the Tundra of Siberia, on the declivities of hills sheltered from the winds and exposed vertically to the sun's rays, the same herbaceous vegetation, with its large, splendidly colored flowers, is observed, but this is not the case in plains where the sunlight in its horizontal direction can not have so much influence on the vegetation of the frozen ground. Therefore these plains are in general really deserts, covered only with moss. Insolation is also the cause of the rich vegetation in some parts of the mountains in the temperate zone. Even in the most northern regions there can be a rich vegetation where the plants in sheltered localities are exposed to the sun. Several instances are mentioned by Mr. Buysman in which plants have been found blooming in these regions while their roots were frozen.

A Bee Nuisance.—M. Delpech, of the Hygienic Council of the Department of the Seine, has published a report on the damage done by bees and the dangers resulting from the existence of apiaries in the city of Paris. The bees, it appears, have become a real and formidable nuisance in some parts of Paris, especially in the neighborhood of the sugar-refineries and the railway-stations, where hundreds of stands are kept. The extent of their depredations upon the Say sugar-refinery is estimated at 25,000 francs, or $5,000, a year. A glass filled with sirup will be emptied by them in less than two hours; and, if a trap is set, more than a hectolitre, or nearly three bushels of them, may be caught in a day.

The laborers in the refinery, who have to work half naked, and whose skin is soiled with molasses, suffer greatly from them, so much that operations have to be suspended at times. Children in the schools near the bee-stands are frequently stung, and horses passing in the neighborhood are in constant danger. M. Delpech maintains that bees are in reality much more dangerous than is generally believed. He makes a triple classification of the accidents that may arise from the wounds they inflict: 1. Trifling accidents, with heat and swelling, followed by a feeling of oppression and itching; 2. More serious accidents, which are cured, beginning with the same symptoms as the former, followed by great weakness, precordial anxiety, cold in the extremities, nausea, insupportable headache, often by nettle-rash, and sometimes by convulsive and tetanic symptoms; 3. Accidents resulting in death, which often speedily follows stings in the face, head, neck, etc. The fatal termination is preceded by two kinds of symptoms—those resulting from local lesions, the exceptional gravity of which is due to the seat of the injury, as where a swelling in the throat is produced resulting in asphyxia; and those in which the toxic action of the poison introduced into the circulation seems to be the immediate cause of death. In this case we have a condition of syncope and asphyxia, with signs of convulsion and tetanus. A considerable number of cases of death resulting from bee-stings are cited in the report.

Ancient House Sanitation.—Dr. W. H. Corfield reviewed the "History of House Sanitation" in an address which he recently delivered, as president, before the English Society of Medical Officers of Health. The necessity of removing surplus rain-water for preventing dampness in the soil of residences has been recognized from the most ancient times, and found emphatic expression in Rome twenty-five hundred years ago, when a grand drainage system for the city, a part of which is still in operation, was constructed by Tarquin the Elder; and the main drain of his work, "The Cloaca Maxima," is styled by Dr. Corfield "the great pattern of all drains." The device for deodorizing excrement by mixing it with dry earth is at least as old as the time of Moses. According to Livy, the Cloaca Maxima was used also to carry away the filth of the city; and, according to Mr. Baldwin Latham, the water-closet is a very ancient device, the use of which "has been traced to all nations that had arrived at a certain degree of refinement." They were probably of Asiatic origin. They were introduced into Rome during the republic; and remains of them have been found in the Palace of the Cæsars at Rome, and in the ruins of Pompeii.

A New Prospective Source of Heat.—Mr. J. Starkie Gardner has published a paper on the utilization of the underground heat of the earth. He holds that the crust of the earth is thin, and that its movements are more compatible with a thickness of ten than of fifty miles. The deepest artesian well in the world is being bored at Pesth, Hungary, with the object of securing an unlimited supply of warm water for the city baths, and has already reached a depth of more than three thousand feet. The present temperature of the water is 161° Fahr., and the borings will be prosecuted till water of 178° is obtained. "It needs no seer," says Mr. Gardner, "to pierce the not distant future when we shall be driven to every expedient to discover modes of obtaining heat without the consumption of fuel, and the perhaps far more remote future when we shall bore shafts down to the liquid layer, and conduct our smelting operations at the pit's mouth."

Bacteria under High Pressure.—M. A. Certes has reported on experiments which he has made on the decomposition of organic matter under high pressure, with the purpose of ascertaining whether the process takes place in the depths of the sea in the same manner as in the open air. He found that bacteria thrive and increase under pressures of from three hundred to six hundred atmospheres, almost as in a normal temperature, except that the microbes are different and the results of their action have only a feeble instead of a strong odor, and are acid instead of alkaline in their reaction. M. Certes will continue his experiments in the winter at the normal temperature of the sea depths, or 39°.

Canadian Forest Preservation.—In his paper at the American Forestry Congress, on "Forest Preservation in Canada," Mr. A. T. Drummond sketched a plan for the preservation and renewal of forests which might in some respects be equally applicable to the United States and Canada. Leases of public timber areas should be restricted to definite periods of five or at most seven years, with a rule that, after the expiration of the lease, the land should have rest for twenty years to allow the young timber to grow up. The timber limits should be restricted in size to about fifty square miles, as is now done in Manitoba. This would enable the Government more systematically to carry out the system of alternate leases and rests. The production of square timber should be discouraged, on account of the great waste of material in forming the square log, and of the additional food for forest-fires which the waste material creates. The cutting on public lands of trees under twelve inches at the stump should be punishable by a heavy fine. This would have the effect of preserving the younger trees till they attained a merchantable size. The starting of forest-fires should be made criminal. Wherever the forests have been cut over by the lumbermen and wherever fires have swept through areas of public lands not specially suitable or available for settlement, reserving or replanting with proper kinds of timber should be attended to. Lastly, the forests should be put under the charge of suitable officers.

Sea Air and Mountain Air.—In a paper on "the Climatic Treatment of Phthisis," Dr. Harold Williams, of Boston, considers the question of what conditions make a climate—say of the sea or the mountains, to either of which patients are generally sent—favorable for the treatment of consumption. They can not be conditions of moisture, or of atmospheric pressure, or of variability of temperature, for these are opposite on the sea and on mountains. The only conditions in which the two classes of location agree with any precision are those of purity of air and of the proportion of ozone constituent. Sea air contains small quantities of saline particles, and of iodine and bromine, while mountain air is usually lower in temperature and more diathermanous; but these are not regarded as essential qualities. One fact to be regarded in considering the question is that, with or without treatment, certain cases of phthisis naturally tend to recovery. Another fact is that any change of climate—which is often accompanied by a change of scene, of habits, of exercise, of food, of dress, of thought, and of surroundings—is of importance in cases of disease. When all the meteorological differences between the air of the mountains and the air of the sea are summed up, the sea-air seems to possess certain possible advantage over that of the mountains, "in that it is warmer and purer, and that it presents slighter variations, both of temperature and humidity. But this, it must be remembered, is the air over the sea itself, air that can only be prescribed through the medium of ocean voyages, a prescription open to the grave objections of idiosyncrasy against the sea; sea-sickness; anxiety at leaving friends, fears of dangers, lack of companionship, variety, and exercise; and, above all, inferiority of food. Added to which is the difficulty of selecting a voyage which shall extend over a sufficiently long period of time." Hence sea air, though perhaps the best of all kinds, is really available for only a few. Island and seaboard stations resemble most nearly the sea, but differ from it with respect to variations of temperature and humidity, and purity of the air. "Physiologically speaking, therefore, it may be said that mountain air is no better than island or seaboard air, because it is colder and more liable to sudden and excessive changes of temperature, while, on the other hand, it may be contended that island or seaboard air is no better than mountain air, because of its diminished purity." An important factor always to be consulted is the idiosyncrasy of the particular patient, for or against the sea or the mountains. "We must admit that, in the present state of our knowledge, the meteorological differences of climate have been proved to be of little importance in the treatment of phthisis." But there are probably beneficial effects of a change of climate which we may regard as due to factors common to all groups of health resorts, and which vary only in degree. These factors are: the change itself; the purity

of the air; the increased number of hours of open-air exercise permitted; and the improved hygienic surroundings of the patient. An ideal health resort for consumption "should be sparsely and newly settled. It should possess a pure water-supply and adequate drainage. It should be of a dry and porous soil, and should be favorably situated with respect to neighboring heights and marshes and prevailing winds. It should be equable in temperature and should possess the maximum of pleasant weather. It should not be so hot as to be enervating, nor so cold as to prevent outdoor exercise and proper ventilation of the houses. It should afford plenty of amusement; it should not be crowded with consumptives, and it should be sufficiently unfashionable to admit of hygienic dress. Above all, it should afford suitable accommodations for the invalid."

Intelligence of Swallows. — Professor Grant Allen, speaking of swallows, says that no other race has lived in such close connection with man and yet learned so little from his companionship. Still, they show some signs of intelligence. In making the mud walls of their nests, for instance, they allow each layer to dry thoroughly before proceeding to top it by another course. In acquiring the habit of building in chimneys, which has been carried to swallows by the westward course of civilization, they exhibit some faculty of adaptation. As a rule they place their nest five or six feet below the top of the chimney, to keep it out of the way of owls, not directly over the kitchen-fire, but over an adjoining flue. And it requires some art to get down into the shaft. The emergence of the young swallows from this place is a remarkable instance of intelligent action still wavering on the brink of mere hardened instinct. As soon as they are strong enough to move, the chicks clamber rather than fly up the perpendicular shaft, by beating their wings "in some ineffectual compromise between a flop and a flutter." Often they fail and fall crushed to the hearth. Then, having reached the summit, it is some time before they venture upon flight, and they acquire the art only by degrees as it were. Mr. Romanes has collected a few yet more unequivocal cases of intelligence in swallows. In one case a bell-wire, on which a swallow's nest partly rested, twice demolished it. Convinced that it was a dangerous object, they constructed a tunnel for the wire to pass through, and were troubled by it no more. In another case a pair of swallows were molested by sparrows trying to dispossess them of their nest. They thereupon modified the entrance to their home, so that, instead of opening by a simple hole, it was carried on outward in the form of a tunnel. Instances are recorded where several swallows have combined to drive away sparrows which had robbed a pair of comrades of their nest.

A Pony Champion.—"Land and Water" has a remarkable story of a pony which saved its master from destruction by a savage dog. The master, a clergyman residing in a lonely neighborhood, was going, with the pony, a retriever, and a Dachshund, while obeying a call to visit a sick parishioner in the night, past a shepherd's cottage where a very fierce dog was kept. This dog, having got loose, made an attack on the party, trying the retriever first and then the Dachshund. The pony became frightened, and the master dismounted, when the dog turned upon him. The affair became very serious for the clergyman; the Dachshund had been put out of the combat, the retriever had hid behind the hedge, and he had to keep up the fight alone, with no other weapon than a riding-whip. Then he "heard a scampering, and the next moment the faithful pony rushed up and darted so suddenly between the combatants that the dog turned tail and fled, evidently thinking the pony to be a larger and dangerous edition of himself. The gallant little fellow pursued the cur until he was fairly chased back to the cottage-door. Then he returned quite docile to his master, and the friendly quartet were able to continue their way in peace and safety once more."

NOTES.

A reproduction in phototype of seventeen pages of a Syriac manuscript, containing the epistles known as the "Antilegomena," is to be published by the Johns Hopkins University, under the editorial supervision

of Professor Isaac H. Hall. The manuscript consists of the Acts and Catholic Epistles, and the Pauline Epistles, with Hebrews, together with tables to find Easter, etc., tables of ecclesiastical lessons, and a poem giving the history of the genesis of the manuscript.

Professor Germain Sée, of Paris, remarks, concerning the alimentary importance of water, that it is essential to dissolve the salts taken in with the food and eliminate them from the system. He denies that man can live on a purely vegetable diet, and points out that the vegetarians themselves confess the fallacy of their theory by using eggs, milk, and butter, by which they make up for the want of solid meat.

Professor H. A. Rowland, of Johns Hopkins University, has completed a photographic map of the solar spectrum, from wave-length 3,680 to 5,790, and has nearly ready the portion above 3,680, to the extremity of the ultra-violet, wave-length about 3,100. A scale of wave-lengths has been added, and the whole is claimed to be more exact and give greater detail than any other map in existence. While the error in wave-length at no part exceeds $\frac{1}{50000}$, the wave-lengths of more than 200 lines in the spectrum have been accurately determined to $\frac{1}{500000}$ part.

A comical feature of the almanacs published for use in Belgium has been brought to light. With the exception of two scientific works, whose editions are limited, they are all—495,000 out of a total of 500,000 copies a year—calculated for Paris. They give the times of the rising of the sun and moon, in which the local difference is often fifteen minutes, for Paris, making at certain seasons the day half an hour longer or shorter than it actually is in Belgium! Eclipses are calculated in detail as for Paris, even if they will not be seen at all in Belgium; and, if such an event should occur as an eclipse visible in Belgium which will not be seen in Paris, the almanac will know nothing about it. The "*Grand double Almanach de Liège*" does not recognize any of the discoveries that have been made in the solar system during the last three quarters of a century!

In addition to three cases previously reported for the current season, the "Lancet" records, in three weeks, three other deaths occasioned by accidents in playing foot-ball. In one case, the victim was kicked in the stomach by an opposing player; the second case was also traced to a kick in the stomach, followed in time by fits; and, in the third case, the player's head, in the rush, was doubled under his breast, and the spinal cord was ruptured. Evidently a reform is needed in the conduct of this game.

An Association for the Protection of Plants was formed at Geneva in January, 1883. On the 1st of January, 1885, it numbered 226 members, resident in eight cantons of Switzerland, with correspondents in France, Belgium, England, and Italy. It has established a garden of acclimatization for Alpine plants, and has distributed the seeds of five hundred species for cultivation in other countries. It has also received, by gifts or exchange, seeds from other countries for its own botanical garden. Its latest "Bulletin" contains a paper on a local flora near Geneva, and a paper by Henry Correvon, director of the garden at Geneva, recommending the cultivation of the edelweiss.

M. Forel has made a communication on the behavior of rivers derived from glaciers, like the Rhine and the Rhône, when they run across lakes. They have been found to preserve their distinct existence, and to continue their course in deep ravines excavated through the lake-bottoms. The ravine of the Rhine in the Lake of Constance has been traced for five kilometres in length and to 1·65 metres below the level of the water. Where it is most largely developed, it is six hundred metres wide and seventy metres deep. The ravine of the Rhône is of similar dimensions, and has been traced for six kilometres. The course of these ravines is tortuous. They appear to be of recent origin, or in course of formation, and are a result of the superior density of the cold, sediment-charged glacial water of the rivers.

The anti-vivisectionists predicted, some years ago, that the investigators to whose objects they are "anti" would come at last to experiment on the human subject. Mr. W. Mattieu Williams has become aware of three instances in which this horrible prediction has been fulfilled, in each case with the full consent of the subject and without injury to him. Pasteur has mutilated human skin and moistened the blood with the poisonous secretions of mad rabbits. Dr. B. W. Richardson has invented a painless cutting-knife, and has tested it upon his own arm. And Mr. Harrison Branthwaite, in the interest of temperance, has administered brandy, for the purpose of testing its thermic effects, to three classes of persons—habitual drunkards, moderate drinkers, and abstainers.

MM. Millardet and Gayon, having manured the vine with sulphate of copper, mixed with lime, find that most of the copper is deposited in the leaf, while merely a doubtful trace can be found in the juice of the grape. Other experiments, with other salts and other plants, indicate that the chlorophyl of the leaves is the most active agent in picking up the foreign matter.

The London "Sanitary World" publishes regularly a "Black-List," including the names of dealers who have been proved to be selling falsified or adulterated goods. It intends to secure for this list the records of all proceedings under the Foods Act, and against the owners of rookeries, throughout England, so that the people of all the villages can learn at once who is cheating them and selling them unwholesome goods.

A new artificial fire-proof stone or plaster has been invented, the principal constituent of which is the mineral asbestine, a silicate of magnesium. This is mixed with powdered flint and caustic potash, and with sufficient water-glass (silicate of soda) to make it into an adhesive plaster. It is further mixed with sand before use. It does not require lathing, but adheres to a smooth surface, and may be applied upon a wall or ceiling of sheet-iron.

For fixing soils in embankments, or where there is wash, reliance is usually placed upon the roots of grass or other plants; and long delays are often incurred, with frequent renewals and repairs of gulleys, before a network of roots can be obtained capable of giving a firm foundation. M. Cambier, of the French railway service, has found in the double poppy a most valuable plant for this purpose. It grows quickly, and helps to support the soil in about two weeks, while, at the end of three or four months, it forms a stronger network of roots than any grass known. It is an annual, but sows itself after the first year.

According to the Newcastle (England) "Journal," Mr. Walter McDonald, of Ilderton, near Wooler, while trying to clear a dam which had been clogged by a freshet, fell into a snow-drift, and might have been buried in it but for the extraordinary sagacity of his collie dog. He was struggling to reach the branch of a tree that overhung him, which the dog observing, it sprang at the branch, pulled it down, and held it within its master's reach till he was able to get a hold upon it.

Mr. Clemens Winkler, of Freiburg, Saxony, announces the discovery by himself, in the new mineral argyrodite, of a new non-metallic element, closely related to arsenic and antimony, to which he has given the name of Germanium.

OBITUARY NOTES.

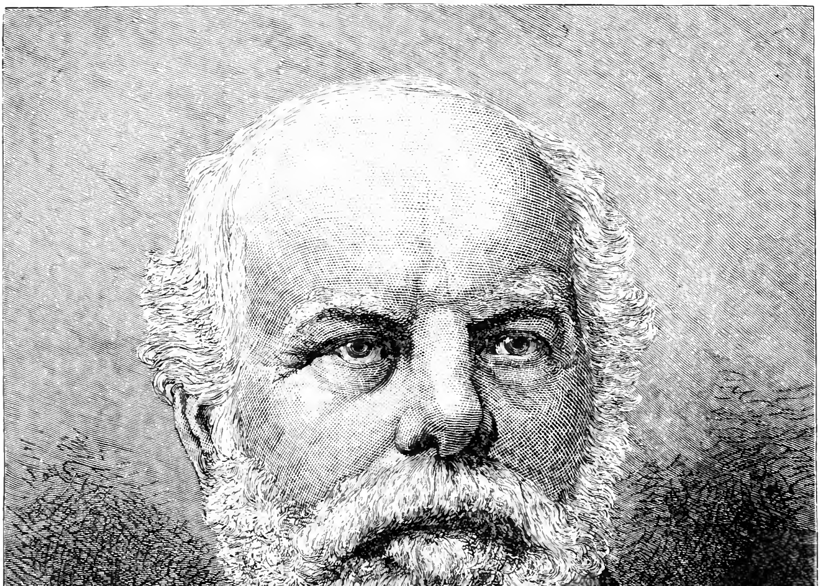
Professor John L. Campbell, of the chair of Geology and Chemistry in Washington and Lee University, died at Lexington, Virginia, February 2d, in the sixty-fifth year of his age. He had been a professor at Lexington since 1851. He was the author of contributions on "Virginian Geology in American Science," his last paper having been a review of the geological reports of Professor W. B. Rogers.

The death of M. Jules Jamin, Perpetual Secretary of the Section of Physical Science in the Paris Academy of Sciences, is announced. He was born in 1813, was elected a member of the Academy in 1858, was an eloquent teacher and debater, and a frequent contributor to the "Revue des Deux Mondes"; he published many papers in the "Transactions" of the Academy, was author of a course in physics for the Polytechnic School, and had patented an electric light.

Mr. Charles William Peach, who was distinguished as a field geologist of the southern coasts of England, died in Edinburgh on the 28th of February, in his eighty-sixth year. He was the son of a country mechanic and inn-keeper, and served in the revenue coast-guards for twenty years, and afterward in the customs, for pay hardly ever much exceeding five hundred dollars a year. He was an industrious collector, and an indefatigable hunter of new species; he became very early acquainted with the marine fauna of his districts; first detected the lower Silurian fossils in the supposed Azoic rocks of Cornwall; furnished the Polytechnic Society in 1843 a valuable paper on land and fresh-water shells and marine animals; discovered the fossils in the altered rocks of the Highlands, which enabled Murchison to elucidate the structure of that region; and has been said by a living geologist to have done more in the field of old red sandstone fossils "than all other geologists put together."

Charles James Edward Morren, Professor of Botany in the University of Liége, died February 28th, in his sixty-third year. He was a son of Professor Charles Morren, of the University of Ghent, who was afterward Professor of Botany in the University of Liége. Being called upon to assist his father in teaching, he prepared, as his especial examination thesis for the doctorate, a dissertation on green and colored leaves, by which he first became known to the botanists of Europe. He succeeded his father as full professor in 1858. He was founder of the Botanical Institute of Liége; editor of the "Belgique Horticole," and author of numerous memoirs and academic dissertations on questions of botany, chemistry, and vegetable physiology.

Dr. Heinrich Fischer, mineralogist and Professor at the Freiburg University, is dead. He was best known by his book on "Jadite and Nephrite."



GEORGE ENGELMANN.

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EVOLUTION BOUNDED BY THEOLOGY.

By W. D. LE SUEUR, B. A.

UNDER the title of "Evolution and Theology," Dr. Lyman Abbott, in the December number of the "Andover Review," undertakes to indicate certain doctrines to which the philosophy of evolution will have to adapt itself, under penalty of being brought to naught. These doctrines, he seems to consider, lend themselves in an especial manner to vigorous and effective pulpit treatment; and his advice to the clergy is to insist as powerfully as possible upon these, and to "leave severely alone doubtful interpretations of the third chapter of Genesis, and doubtful discussions respecting the origin of the race." In other words, the difficulties raised by science in regard to the Biblical account of creation are to be quietly ignored, while all possible use is to be made for purposes of edification of such doctrines as appeal most powerfully to the religious emotions. One may agree with the writer that it is not well to spend time upon "doubtful interpretations," and yet hold that it would not be useless to inquire whether a narrative accepted by thousands as historically true has any just claim to be so regarded. A certain passage in Homer might be considered by critics as hopelessly "corrupt"; but the fact of our giving up the effort to interpret it would not stand in the way of our forming an opinion as to whether the Homeric tale of Troy was to be accepted as sober history. What simple-minded people want to know, in regard to the early chapters of Genesis, is whether or not they are *true*, and this issue can not be evaded by any talk about "doubtful interpretations." What is meant, after all, by "doubtful interpretations"? Is it meant that it is impossible to put any certain interpretation upon the chapters in question? That difficulty was not felt in former times, when days counted as days, and the geological record was as yet un-

read. There is, however, probably no use in pressing this point further. Dr. Abbott simply formulates a policy—the policy of those who know enough and have reflected sufficiently to understand that the recent work of science calls for *some* readjustment of ancient opinions even in theological matters, but who would prefer not to ascertain too precisely what the amount of that necessary readjustment is. There are others, of course, who make no terms with the scientific enemy, and persist in holding all declarations of Scripture as equally challenging and commanding the most submissive acceptance. Thus Mr. Moody, not long ago, desiring to flout the skeptics with an extreme example, declared his firm belief in the historical truth of the narrative of Jonah! The doctrine of evolution does not trouble Mr. Moody in the least. He takes the Bible as he finds it, disdaining all criticism that does not start from the assumption of its infallibility. The position of Dr. Lyman Abbott is different: evolution troubles him just to this extent, that he would apparently like to chain it to three theological cannon-balls, and then let it roam about with whatever ease and freedom might be possible to it under the circumstances.

It becomes a question, therefore, whether the proposed limitations of the doctrine of evolution, or rather of philosophy in general, can be accepted without sacrifice of the supreme interests of truth. The latter—truth in the widest sense—is and must be the ultimate standard. However valuable or important a system of thought may be in the eyes of its adherents, it can not safely be made a standard by which to test other doctrines: these may always claim a free and fair trial apart from all presumptions created by the credit attached to established opinions. Once make any *system* the supreme arbiter, and an intellectual tyranny has been created, the ultimate effects of which can not fail to be disastrous. The world has seen such tyrannies in the past; and, unhappily, is not rid of them in the present. The Romish Church is such a tyranny, setting itself up, as it does, as the supreme arbiter of truth. The Westminster Confession is the symbol of another tyranny of an essentially similar character. Could certain persons to-day have their way, a kind of composite evangelical doctrine would have its place in public-school instruction, and would thus be created into a tyranny over the community at large. "Ye know not what mind ye are of," was said by the founder of Christianity to some of the more zealous of his disciples; and the remark might well be addressed to-day to those who are trying to gain for their private beliefs the authority and support of the state. Could they have their way, the time would undoubtedly come when they would rue it.

Before proceeding to define the doctrines by which he would propose to check the hypothesis of evolution, Dr. Abbott assigns to the scientist and the theologian the fields in which they are respectively permitted to work, and describes their respective methods of operation. "The scientist," he tells us, "has external Nature for his field,

and observation for his instrument of acquisition; the theologian has the human mind for his field, and consciousness for the instrument of his observation." This seems to me, I must confess, a very singular utterance. In the first place, why should the scientist be said to have an "instrument of *acquisition*," namely, observation, and theology only an instrument of *observation?* In what sense can consciousness be said to be an "instrument of observation"? And if it is an instrument at all, how is it that its use is confined to the theologians? No doubt the theologian requires consciousness in order to observe, but so, I fancy, does everybody else. These objections, however, tend only to show that Dr. Abbott has used some rather crude and ill-considered expressions; but when we pass to his dictum that natural science has to do only with external Nature, and not with the human mind—the latter falling within the exclusive domain of theology—a stronger protest becomes necessary. The word "natural" here prefixed to science seems almost as if it were intended to smooth the way for the acceptance of a larger doctrine than the writer cared to put expressly forward. What many would like to think is that science—human science—has nothing to do with mind. Dr. Abbott does not go as far as this: he only says "natural science," meaning, doubtless, in his own mind, physical science; but those who want to hold the wider proposition will either overlook the word "natural" altogether, or will interpret it as opposed to "spiritual." The real question is, Does science—such science as man can construct by the aid of his natural faculties—throw any light on mind? If it does, then we are not left entirely to theology to interpret mind for us. If it does not, and if theology does, then let us place ourselves in the hands of theology; for assuredly the subject is one on which we want all the light we can get. The real fact is, that science is pushing its researches into mind with no less vigor than into material things; and in the face of such works as those of Bain, Spencer, Maudsley, Taine, Wundt, and many others, it sounds very odd to find a well-known and able writer claiming the whole field for theology.

To proceed, however, the first restriction which the evolution philosophy is called upon to observe is expressed in the proposition that "we are the children of God." "We"—who? The whole human family, it must be presumed, from the highest types of European and American civilization to the most degraded savages that walk the earth. This, we are told, is more than a revealed doctrine; it is the verdict of "the universal consciousness." If so, why put in a *caveat* that evolution must not go counter to it? Surely, if the very consciousness of the evolutionists themselves, in common with that of the masses of mankind, bears witness to this doctrine, it might be regarded as reasonably secure against attack from any quarter. Yet evidently Dr. Abbott, in spite of the sweeping character of his affirmation, has doubts in regard to what the evolution philosophy may do or attempt

to do in the premises. How is this contradiction to be explained? The explanation, as we conceive, lies here: There are two aspects of the doctrine to which the reverend doctor refers—one the purely religious, the other what we may call the historico-theological. In regard to the first of these he feels, and, as we hold, is justified in feeling, unbounded certainty; in regard to the second, he does not feel so certain, and yet he can not help regarding it as essential to the integrity of the first. It is the latter to which he fears the solvent of evolution may be, if it has not already been, applied with disintegrating effect.

Let us explain this further. The statement that we are the children of God, in so far as it is an affirmation of consciousness, can only mean that we feel related to the highest object or ideal that our minds can frame. We may here make a new application of the poet's words:

> "'Tis life whereof our nerves are scant—
> O life, not death, for which we pant;
> More life and fuller that I want."

The "fuller life," for which we all, at one moment or another, pant, is that which comes of subjection to the higher law. We feel that evil in our nature bounds and hampers us on every side; that through it our lives are rendered poor and incomplete. This thirst for a higher, fuller life, is as far removed as possible from mere self-worship, or any kind of moral *dilettanteism*; seeing that what we seek is not an addition to our individual forces for individual purposes, no mere higher form of culture, but rather the perfecting of our nature through conscious relation with that which transcends and yet embraces it. "We grow in elevation and nobleness of nature just in proportion as we merge our individual life and happiness in the happiness and life of others." These words of Dr. Caird's ("Scotch Sermons," page 36) contain, as we think, in germ, the whole philosophy of religion. Manifestly, it is impossible to conceive that evolution, or anything else, should ever destroy the forward and upward-reaching tendencies of human nature, or, in other words, affect, *in its religious aspect*, the affirmation that "we are children of God." Even those—and in the present day they are many—who through fear of being misunderstood might refrain from using these precise words, would still be prepared to understand in them the substantial and essentially religious truth of man's dependence on and affinity with a higher unity than that of his individual organism.

It is otherwise, however, with the same affirmation in its historico-theological aspect. The doctrine of evolution can only deal with facts, with these it does deal. If authentic history can show that the human race is descended—by procreation, as Dr. Abbott says—from God, in the same way as the Romans claimed to have been descended from Æneas and his band of Trojans, well and good; evolution can have

no more objection to that fact than to any other. Only in that case God would be a known term in a known series of phenomena; and such a thing, we need hardly say, is scarcely conceivable by any mind raised above the condition of barbarism. Ancient history, of course, is full of just such definite statements. Romulus had the god Mars for his father; Æneas the goddess Aphrodite for his mother, and so on *ad infinitum*. If Dr. Abbott means what he says about the human race in a literal sense, he should point us to the historical record; and, it is needless to say, that record should not be one lending itself to an infinity of "doubtful interpretations." Where is the record? But is it not perfectly manifest that, considered as the historical statement of what happened thousands of years ago, it is utterly impossible that the "universal consciousness" should bear witness to the procreation—the word is Dr. Abbott's—of the first man by the God of the book of Genesis? It is said to be a wise child that knows its own father; and, as to a child's being *conscious* who its own father is or was, the idea is simply irrational. It would seem as if Dr. Abbott, while discouraging inquiry into the meaning of the opening chapters of Genesis, desires, as far as possible, to save their credit, and so claims that consciousness confirms the account they contain of the origin of mankind. Consciousness, however, does nothing of the kind—could not, by any possibility, do anything of the kind—and if the evolution philosophy should come into collision with the Mosaic account of man's creation, it will have to deal, not with an affirmation of the "universal consciousness," but simply with an ancient legend hardened into a dogma. It has had some experience already in dealing with such things, and need not quail at the prospect of another encounter. It is really very idle thus to try to frighten away Science from ground that it is entirely fitted to occupy. The effort irresistibly reminds one of the attempts that savages make to avert an eclipse by the vigorous beating of tom-toms. Unaffrighted by all the tom-toms of the pulpit and the theological press, modern science will press steadily forward, grasping at all facts, and reducing them, as fast as possible, to order and harmony. It is already concerning itself with the origin of mankind; and has taught us more upon that subject than all the theologies and mythologies put together. We may claim to know now that primitive man had *not* a very profound or very enlarged consciousness of a divine descent, and that any ideas of divinity that he possessed were not inconsistent with a lively cannibalism. But it is science that teaches us this, and not the book of Genesis, which starts man on his career with a respectable equipment of theological and industrial knowledge. Dr. Abbott may count with confidence upon a complete abstention on the part of science from any interference with the devout experiences or exercises of any human soul; but, unless he wishes to see his counsels brought to naught, he will himself refrain from any attempt to check science in its career

of discovery, or prevent it from drawing such conclusions as may seem reasonable from the facts that come within its range.

The second doctrine which the evolution hypothesis is solemnly warned not to contradict is that which affirms that "mankind has sinned and come short of the glory of God." Guilt and imperfection, we are told—and, as the present writer thinks, truly—are not synonymous. "Sin is always a fall; when we sin we go down from a higher to a lower life." Now, what the evolutionist is concerned to know, is whether he is required to affirm, or at the very least to refrain from denying, that man was originally created perfect, and that, from that condition of perfection, he fell by sin, more or less in the manner described in the third chapter of Genesis. Dr. Abbott is not as distinct upon this point as might be desired. Making all allowances for his natural desire to "leave severely alone doubtful interpretations of the third chapter of Genesis, and doubtful discussions respecting the origin of the race," we might still have expected him to tell us clearly whether he holds that the first human pair were created perfect—"very good" from every point of view—and whether this is what he requires the evolutionist also to believe. The latter might, I fear, have some trouble with a doctrine of this kind; but if he is merely asked to believe that there is a radical difference between guilt and imperfection, he will not only be able to toe the mark without difficulty, but, with the aid of Mr. Spencer, he will be able to discourse somewhat pertinently on the differences between guilt and imperfection. The sense of guilt arises, he will say, when some higher law of conduct, the moral authority of which has been established in the manner described in Chapter VII of the "Data of Ethics," has been set aside under the influence of some lower but more clamorous motive. Such lapses are incidental to man's upward struggle; and in every such case he undoubtedly has the sense of a fall. The illustrations which Dr. Abbott gives of his meaning lead to the belief that he understands nothing more by guilt than the falling away from some recognized standard, some attained level, of conduct. If so, he has gone out of his way to give a very unnecessary warning to his evolutionist brother. "Every broken resolve," he says, "every high purpose lowered, every sacrifice of reverence to sensual desire, of conscience to passion, of love to greed, or ambition, or wealth, is a fall." Surely no decently-read person supposes there is anything in the evolution philosophy that conflicts with this. What the evolutionist is in doubt about is whether the story of *the* Fall, as embodied in Christian doctrine, is a true story—whether the first human being was all made up of high purpose, reverence, conscience, and love, and whether from that pristine condition of purity he fell, by one act of disobedience, into that condition of utter corruption described by theologians. There is no use in mincing matters or using vague language. Either Dr. Abbott summons the evolutionist to incorporate this doctrine in his philoso-

phy, or he does not. If he does, then there will be trouble; for the evolutionist will ask for evidence that will scarcely be forthcoming. If he does not, but merely asks the evolutionist to allow in his system a place for the sense of sin, the reply of the latter will undoubtedly be: My dear sir, you are going to unnecessary trouble in this matter; for the school to which I belong not only recognizes the fact to which you refer, but may even claim to have scientifically explained it years ago.

The third test-doctrine is that of redemption. Evolution must bow to this also, or else go on its way to destruction. At first sight the condition may seem hard, but Dr. Abbott has a rare faculty for minimizing difficulties. Just as he illustrated the Fall for us by referring to the decadence of Greece, Italy, and the Southern States of the Union—the points of comparison in the latter case being "the moral utterances of Jefferson and Madison," on the one hand, and those of the pro-slavery leaders of the period just prior to secession on the other—so, when it comes to expounding redemption, he exhibits it to us in the action of a higher personality upon a lower: that, for example, of father, mother, or teacher upon the wayward character of a child. It is true that he adds: "No soul, and so no aggregation of souls, can climb up to God; he stoops down and lifts us up to himself." But this, again, is manifestly the language of devotion. How can science take any cognizance of such terms? Professor Huxley spoke not irreverently, but simply as a man of common sense, when, in his recent controversy with Mr. Gladstone, he observed that he could not match any detail of the nebular hypothesis with the scriptural statement that "the spirit of God moved on the face of the waters." To throw such declarations at the man of science, and ask him what he makes of them, is eminently unreasonable. They may and do find an echo in the religious nature; but they do not lend themselves to any kind of scientific appraisement. The business of science, it can not be too often repeated, is not to force its way into men's hearts, and lay a ruthless hand upon the altar of the religious life. It is none of its business to apply rule or plummet, or any other instruments of exact determination, to the religious aspirations, or to the forms or formulas in which these express themselves. Its business is with definite, determinate facts or statements; it builds alone upon these, it concerns itself alone with these. It respects the religious life, and would willingly draw a wide precinct around it to preserve it from all undue intrusion. But, on the other hand, it claims complete independence within its own region, and will not surrender one atom of determinate fact, or forego a single one of its conclusions, because, forsooth, some one asserts that the interests of religion are involved in having the fact or the conclusion so, rather than so! Religion has to learn that it can neither make nor mold facts, nor arbitrarily control logical processes. It must learn to be self-sufficing in its own

region—the region of the higher emotions—and to respect science as it would have science respect it. Then all will be well.

It is observable that Dr. Abbott is no more anxious to discuss the strict theological doctrine of redemption than he is to enter into the details of the third chapter of Genesis. He prefers to deal with the process of redemption in its most general aspects, as consisting in the action of a higher nature on a lower. Taken in this accommodated and accommodating sense it is not at all hard to believe in ; and the evolutionist may well congratulate himself that a term of such special theological import, so commonly associated with the supposed efficacy of bloody sacrifices, is capable of being explained by a doctor of divinity in so natural and human a manner. It is satisfactory, also, to note that the reverend doctor does not summon the modern philosopher, on pain of intellectual confusion, to accept the Bible or any portion of it, but only such truths as are affirmed by the "universal consciousness." He mentions certain chapters of the Bible, but chiefly for the purpose of deprecating the spending of much time upon a discussion of their meaning. In spite, therefore, of an apparently aggressive tone, the learned doctor's article, when closely examined, may almost be regarded as a kind of Eirenicon. Possibly, like a very ancient scriptural character, he may have meant to say worse things than he actually succeeded in uttering. Science has its foes, who would like to hear it denounced ; but it is not always easy to command the prophets. Many of them know too much, and are too sound at heart, to rail at the modern Israel.

A few words in conclusion. The evolutionist, or, as we should prefer to say, the modern scientific thinker, is not necessarily or naturally an irreligious man. Conversing, as he tries to do, with truths of deep and wide significance, and seeing, as perhaps no one not engaged on equally wide questions can see, the littleness of all individual thought and effort in comparison with the vast operations of Nature and the limitless record of human action in general, he is not prone either to set his own personality up as an object of worship, or voluntarily to cage himself in a narrow materialistic philosophy. What he sees and feels at every moment is, that the universe outruns him on every side, and that he can only be baffled and beaten in any attempt to do more than take due note of the succession of phenomena. It is a duty with him, however, to limit his affirmations to the exact facts he has observed. To go beyond them would be to him as distinctly a sin as to others it would be an act of piety. This is why he can not join in many of the devout phrases by which others ease their hearts. It is not that his heart does not at times require easing too, or that these phrases have not, considered in themselves and in their associations, a decided efficacy for that purpose, but simply that he does not himself feel authorized to make the affirmations which the phrases either make or imply. The average member of society has probably little

idea of the emotional sacrifices which the philosopher makes in order to preserve his intellectual integrity, and to keep inviolate for others truths which he believes they will one day, to their great advantage, recognize. Were he alone concerned, he might—in most cases probably would—yield to the force of surrounding opinion and social practice; but a secret instinct tells him that he is the conservator of that which he has no right to sacrifice, or even to compromise, in the interest of his personal convenience or comfort. Such a man may, as I conceive, worship the Unknown God with as true a devotion as has ever been shown at the shrine of any of the named divinities of the human race. He may lack a liturgy and articles of belief; but he does not mourn the absence of these, finding his mind all the freer to turn its gaze ever to the pole-star of truth, and his heart the more open to every good impulse and to all the best teachings of the great world-drama that enacts itself before his eyes. Such a man can afford to be misunderstood, not so much because of his confident appeal to the future, as because of the *present* sustaining power of a loyal submission to the truth. When theologians, even such amiable ones as Dr. Lyman Abbott, undertake to tell him what he must incorporate into his system of thought, or what venerable doctrines he must bow to in passing, he says to himself, in the language of Socrates, "Whither the sea-breeze of reason carries us, thither must our course be bent." And so, in spite of all pulpit denunciation, and in spite of all the pleading, special and general, of those who would keep humanity fettered to the doctrines of the past, modern thought keeps on its way, seeing, believing, harmonizing, hoping, and looking to be justified some day of its children.

AN ECONOMIC STUDY OF MEXICO.

By Hon. DAVID A. WELLS.

III.

Occupations of the People of Mexico. *Agriculture.*—Although the main business of the country is agriculture, this branch of industry is carried on under exceptionally disadvantageous circumstances. One of its greatest drawbacks is, that the whole country is divided up into immense *haciendas,* or landed estates; small farms being rarely known; and out of a population of ten million or more, the title to the soil is said to vest in not more than six thousand persons. Some of these estates comprise square leagues instead of square acres in extent, and are said to have irrigating ditches from forty to fifty miles in length. Most of the land of such estates is uncultivated, and the water is wasted upon the remainder in the most reckless manner. The titles by which such properties are held are exceedingly varied,

and probably to a considerable extent uncertain. Some came from the old Spanish Government, through its viceroys; some from Mexico, through its governors or political chiefs; while over a not inconsiderable part of all the good land of the country, the titles of the Church, although not recognized by the Government, are still, to a certain extent, respected. Added to all this, there is a marked indisposition on the part of the large owners of real estate in Mexico to divest themselves of such property; and this for various reasons. Thus, in the heretofore almost permanently revolutionary condition of the country, the tenure of *movable* or personal property was subject to embarrassments from which real estate, or *immovable* property, was exempt. Under the system of taxation which has long prevailed in Mexico, land also is very lightly burdened. And, finally, from what is probably an inherited tradition from Old Spain, the wealthy Mexican seems to be prejudiced against investing in co-operative (stock) or financial enterprises—the railways, banks, and mines, in both Old Spain and Mexico, for example, being to-day mainly owned and controlled by English or other foreign capitalists. Under such circumstances, there is no influx of immigrants into Mexico with a view to agriculture, and settlements, such as spring up and flourish in the United States almost contemporaneously with the construction of the "land-grant" and other railroads, are unknown, and are not at present to be expected; all of which clearly works to the great disadvantage of all Mexican railway enterprise and construction. It is also interesting to note, in connection with this subject, that it is the immobility and uncertainty of these same old Spanish or Mexican land-grants, which cover a vast portion of New Mexico, that constitute at present the greatest obstacle in the way of the growth and development of that Territory.

Statutes offering great inducements for permanent immigration—such as a bonus to each immigrant, the right to purchase public lands at moderate prices and on long terms, the right to naturalization and citizenship, and the like—were enacted by the Mexican Congress as far back as 1875, but as yet do not appear to have been productive of any marked results.

On the other hand, the Mexican land laws discriminate very rigorously against the acquirement of land by foreigners who do not propose to become Mexican citizens, and seem to be especially framed to prevent any encroachments on the part of the United States. Thus, no foreigner may, without previous permission of the President of the Republic, acquire real estate in any of the border States, within twenty leagues (sixty miles) of the frontier; but such permission has of late been freely given to citizens of the United States for the acquirement of ranching property on the northern frontier. The ownership of real estate by a foreigner in either country or city, within fifteen miles of the coast, is, however, absolutely forbidden, except on the condition of a special act of Congress granting it. It is only,

furthermore, through a direct permission of the Minister of Foreign Affairs that a foreigner in Mexico is accorded any standing in a court of justice. By the Constitution of Mexico, a foreigner who purchases any real estate in that country, without declaring that he retains his nationality, becomes a citizen of Mexico; and it is difficult to see how under such conditions he could properly invoke any protection from the country of his prior citizenship, in case he considered his rights in Mexico to be invaded. Again, the laws regulating mining property in Mexico are very peculiar. No one in Mexico, be he native or foreigner, can own a mine absolutely, or in fee, no matter what he may pay for it. He may hold it indefinitely, so long as he works it; but under an old Spanish law, promulgated as far back as 1783, and still recognized, if he fails "to work it for four consecutive months, with four operatives, regularly employed, and occupied in some interior or exterior work of real utility and advantage," the title is forfeited and reverts to the state; and the mine may be "denounced," and shall belong, under the same conditions, "to the denouncer who proves its desertion." The denouncer, to keep the property, must, however, at once take possession and begin the prescribed work within a period of sixty days. This practice has one great advantage over the American mining system; and that is, that litigation about original titles, and conflicting claims to mining property are almost unknown in Mexico.

On the *plateau* of Mexico, where nine tenths of its present population live, there is undoubtedly much good land; but the great drawback to this whole region is its lack of water. During the rainy season, which commences in June and lasts about four months, there is a plentiful rainfall for Central and Southern Mexico; but in Northern Mexico the rainfall, for successive years, is not unfrequently so deficient as to occasion large losses, both in respect to stock and to crops. For the remainder of the year, or for some eight months, little or no rain falls, and the climatic characteristic is one of extreme dryness. During the most of the year, therefore, the whole table-land of Mexico is mainly dependent for its water-supply upon a comparatively few springs and storage-reservoirs; and agriculture can not be generally carried on without resorting to some form of irrigation. One rejoinder to what may be an unfavorable inference from these statements has been the counter-assertion that "in the immediate neighborhood of the large cities enough grain is raised by irrigation to keep constantly more than a year's extra supply ahead to provide against a possible failure of crops"; and, further, that the storage capacity of the existing reservoirs of Mexico might easily be increased, and thus greatly extend the area of land capable of cultivation. But, admitting this, how great must be the obstacles in the way of developing any country where there is a liability to an almost entire failure of the crops from drought; and where the small agricultural proprietor,

who depends on each year's earnings to meet each year's needs, has always got to anticipate and guard against such a possibility! There are vast tracts of land also in Mexico, especially in the northern part, where grass sufficient for moderate pasturage will grow all or nearly all the year, but on which the water-holes are so few, and so entirely disappear in the dry season, that stock can not live on them. In a report recently sent (January, 1885) to the State Department, by Warner P. Sutton, United States consul-general to Matamoros, the statement is made, that the annual value of the agricultural products of the State of South Carolina, having an area of 30,570 square miles, is at least two and half times as great as the whole like product of the six States of Northern Mexico—namely, Tamaulipas, Nuevo Leon, Coahuila, Chihuahua, Lower California, and Sonora—which have an area of 355,000 square miles, and represent about one half of the territory of the whole republic; or, making allowance for the areas of land under comparison, the annual agricultural product of South Carolina is from twenty to twenty-five times as valuable as that of the whole northern half of Mexico!

On the "*tierras calientes*," or comparatively narrow belt of coast-lands, on both the Atlantic and Pacific sides of Mexico, there is abundance of wood and water, cheap and fertile land, and most luxuriant vegetation; but the climate is such that the white races will never live there in the capacity of laborers. When one hears, therefore, of possibilities of these regions in respect to coffee, sugar, tobacco, and a wide range of other valuable tropical products, this fact has got to be taken into account. They would, however, seem to be particularly adapted to the introduction and employment of Chinese labor; and during the past year delegations from the associated Chinese Companies of San Francisco have, it is understood, entered into negotiations with the Mexican Government, with a view of promoting an extensive immigration into these portions of the national territory.

Again, much of the best land of the plateau of Mexico is in the nature of valleys surrounded by mountains, or of strips or sections separated by deserts. Thus, for example, to get from the city of Mexico into the fertile valley of Toluca, a comparatively short distance, one has to ascend nearly three thousand feet within the first twenty-four miles; while between Chihuahua and Zacatecas there is an immense desert tract, over which the Mexican Central Railway has to transport in supply-tanks the water necessary for its locomotives. It is true that in both of these instances the natural difficulties have now in a great measure been remedied by railroad constructions; but when it is remembered that, outside of the leading cities and towns of Mexico, there are hardly any wheeled vehicles, save some huge, cumbersome carts with thick, solid, wooden wheels (a specimen of which, exhibited as a curiosity, may be seen in the National Museum at Washington); that the transportation of commodities is mainly ef-

fected on the backs of donkeys or of men; that the roads in Mexico, as a general thing, are hardly deserving of the name;* and that, even with good, ordinary roads and good teams and vehicles at command, a ton of corn worth twenty-five dollars at a market is worth nothing at a distance of a hundred and twenty miles—remembering these things, one can readily accept the statement that, in many sections of Mexico, no effort is made to produce anything in the way of crop products, except what has been found necessary to meet the simplest wants of the producers; and for the reason that experience has proved to them that it was not possible to obtain anything in exchange for their surplus.

The plow generally in use in Mexico is a crooked stick, with sometimes an iron point. American plows are beginning to be introduced to a considerable extent; but the Mexican peasant on coming into possession of one generally cuts off one handle, in order to make it conform, as far as he can, to his ancient implement. A bundle of brush constitutes the harrow. "Their hoes are heavy grub-hoes, and grass is cut by digging it up with such a hoe."

Nothing exhibits more strikingly the present poverty of Mexico, and the present inefficiency of her agriculture—notwithstanding the natural advantages claimed for this industry, and that it is undoubtedly the principal occupation and support of her people—than a brief comparison of some of the results which have been recently reported for Mexico and the United States. According to a report published in 1883, by M. Bodo von Glaimer, an accepted Mexican authority, and other data, gathered and published by Señor Cubas, United States Consul-General Sutton, and the Agricultural Bureau at Washington, the value of all the leading agricultural products of Mexico—corn, wheat, sugar, tobacco, beans, coffee, and the like—for the year 1882 was estimated at about $175,000,000. But the present estimated value of the oat-crop alone of the United States is $180,000,000. Again, corn constitutes the staple food of the Mexican people, and its product for 1882 was estimated at about 213,000,000 bushels; which, with an assumed population of ten million, would give a product of $21\frac{3}{10}$ bushels per capita. But for the United States for the year 1885 the product of corn was about thirty-three bushels per capita.

Although much of the soil of Mexico is undoubtedly well adapted to the cultivation of wheat, it is as yet a crop little grown or used—wheat-bread being eaten only by the well-to-do classes. Its product

* One of the most noted routes in Mexico is from the capital to Acapulco, the best Mexican port on the Pacific, a route that was traveled, and constituted a part of the transit for convoys of treasure and rich tropical products between the Indies and Old Spain, a hundred years before the Pilgrims landed at Plymouth. And yet a journey over this route, a distance of three hundred miles, consumes ten days on horseback under the most favorable auspices; and the path or trail followed has in great part so few of the essentials of a road that, in popular parlance, it is spoken of as "*buen camino de pajaros*" (a good road for birds).

for 1882 was estimated at 12,500,000 bushels, or at the rate of about $1\frac{2}{10}$ bushel per capita; while for the year 1885, with a very deficient crop, the wheat product of the United States was in excess of six bushels per capita. Mexican coffee is as good as, and probably better than, the coffee of Brazil, and yet Mexico in 1883–'84 exported coffee to all countries to the value of only $1,717,190, while the value of the exports of coffee from Brazil to the United States alone, for the year 1885, was in excess of $30,000,000. Much has also been said of the wonderful adaptation of a great part of the territory of Mexico for the production of sugar, and everything that has been claimed may be conceded; but, at the same time, sugar is not at present either produced or consumed in comparatively large quantities in Mexico, and, in common with coffee—another natural product of the country—is regarded rather as a luxury than as an essential article of food. Thus the sugar product of Mexico for the year 1877–'78, the latest year for which data are readily accessible, amounted to only 154,549,662 pounds. Assuming the product for the present year (1886) to be as great as 200,000,000 pounds, this would give a Mexican per capita consumption of only twenty pounds as compared with a similar present consumption in the United States of nearly fifty pounds. The further circumstance that Mexico at the present time imports more sugar than it exports; and that the price of sugar in Mexico is from two to four times as great as the average for the United States—coarse-grained, brownish-white, unrefined sugar retailing in the city of Mexico for twelve and a half cents a pound (with coffee at twenty-five cents)—is also conclusive on this point. With the present very poor outlook for the producers of cane-sugars in all parts of the world, owing mainly to the bounty stimulus offered by the governments of Europe for the production of beet-sugar; and the further fact that the only hope for the former is in the use of the most improved machinery, and the making of nothing but the best sugars at the point of cane production, the idea so frequently brought forward that labor and capital are likely to find their way soon into the hot, unhealthy coast-lands of Mexico, in preference to Cuba and South America, and that the country is to be speedily and greatly profited by her natural sugar resources, has little of foundation. And, as additional evidence on these matters, the writer would here mention, that a statement has come to him from a gentleman who has been long connected and thoroughly acquainted with the Vera Cruz and City of Mexico Railroad, which runs through the best sugar and coffee territory of the country, that not a single acre of land more is now under cultivation along its line than there was at the time the road was completed, thirteen years ago.

Whatever, therefore, may be the natural capabilities of Mexico for agriculture, they are certainly for the future rather than of the present.

Manufactures.—Apart from handicrafts there is very little of manufacturing, in the sense of using labor-saving machinery, in Mex-

ico; and, in a country so destitute of water and fuel, it is difficult to see how there ever can be. In almost all cases where the employment of machinery is indispensable, mule or donkey power seems to be the only resource; as is the case in the majority of the mines and silver-reducing works of the country—not a pound of ore, for example, being crushed through the agency of any other power, in connection with the famous mines of Guanajuato. Many years ago an English company bought the famous *Real del Monte* mine, near Pachuca, which is reported to have yielded in a single year, with rude labor, $4,500,000. It was assumed that two things only were requisite to insure even greater returns; namely, the pumping out of the water which had accumulated in the abandoned shafts, and the introduction of improved machinery for working at lower levels. Large steam-engines and other machinery were accordingly imported from England, and dragged up by mule-power from Vera Cruz, at immense cost and labor. But the new scheme proved utterly unprofitable, and after some years' trial was abandoned. The expensive machinery was sold for about its value as old iron; the mines reverted to a Mexican company; the old methods were again substantially introduced, and then the property once more began to pay.

Deposits of coal of good quality are from time to time reported as existing, and readily accessible. But the fact that the Mexican Central Railroad supplies itself from the coal-fields of Colorado, nearly fifteen hundred miles from the city of Mexico, and that the Vera Cruz Railroad imports its coal from England, is in itself sufficient evidence that no coal from any Mexican mine has yet been made practically available for industrial purposes. In Central Mexico, wood commands at the present time from twelve to sixteen dollars per cord, and coal from fifteen to twenty-one dollars per ton.

According to the best information available, the number of factories of all kinds using power, in the republic, is about a hundred, representing a valuation of some $10,000,000, and employing about 13,000 hands. Their range of manufacturing is exceedingly limited, and comprises little besides the coarser cottons and woolens, the coarser varieties of paper, a few (cloth) printing and dye works, milling (flour), and the manufacture of unrefined sugar. The textile factories (cotton and wool) are said to contain 250,000 spindles and 9,500 looms.

No country affords such striking illustrations as Mexico of the fallacy and absurdity of the so-called "pauper-labor" argument for "protection"; or of the theory, which has proved so popular and effective in the United States, for justifying the enactment of high tariffs, that the rate of wages paid for labor is the factor that is mainly determinative of the cost of the resulting product; and that, therefore, for a country of average high wages, the defense of a protective tariff against a country of average low wages, is absolutely necessary as a condition for the successful prosecution by the former of its industries.

Wages, on the average, in Mexico, are from one half to two thirds less than what are paid in similar occupations in the United States; and yet in comparison with the United States the price of almost all products of industry in Mexico is high. Thus, in the city of Mexico, where wages rule higher than in almost any part of the republic, the average daily wages in some of the principal occupations during the year 1885 were as follow: Laborers, porters, etc., forty to fifty cents; masons, seventy-five cents to one dollar; assistants, thirty-seven and a half to fifty cents; teamsters, fifty cents; blacksmiths, one dollar and fifty cents; printers, one dollar; saddle and harness makers, sixty-two cents; tailors, seventy-five cents; painters, eighty-seven and a half cents; weavers in the cotton-mills at Tepic and Santiago, four dollars per week of seventy-two hours; spinners, three dollars ditto. In the cotton-mills in the vicinity of the city of Mexico a much higher average is reported. The operatives in the woolen manufactories of Mexico are in receipt of higher average wages than those in almost any other domestic industry; and Mexican woolen fabrics are comparatively cheap and of good style and quality. Underground miners, at the great mines of Zacatecas and Guanajuato, receive an average of nine dollars per week of sixty hours; underground laborers, three dollars ditto; agricultural laborers in the district of San Blas average nineteen cents per day, with an allowance of sixteen pounds of corn per week. On a *hacienda* near Regla, in Central Mexico, comprising an area some eighteen miles in length by twelve in its greatest breadth and including an artificial lake two miles in its principal dimensions, the wages paid in 1883 were six cents a day for boys and thirty-seven cents for the best class of adults. In other districts the wages of agriculturists are reported as from eight to ten dollars per month, with rations.

The following are the retail prices of some of the principal articles of domestic consumption in Mexico: Fresh beef, twelve to eighteen cents per pound; lard, twenty to twenty-five cents; coffee, twenty-five cents; sugar, unrefined, twelve to twenty cents; table-salt, six cents; potatoes (city of Mexico), twenty-five cents per dozen; flour, ten to twelve cents per pound; corn-meal, not usually in the market, unless imported; candles, thirty to fifty cents; unbleached cottons, ten to fifteen cents per yard; calicoes, fifteen to twenty cents per yard. Utensils of tin and copper are fifty per cent dearer than in the United States; while the retail prices of most articles of foreign hardware (and none other are used) are double, treble, and even four times as much as in the localities whence they are imported. "Between the extremes, a modest and economical lady's wardrobe will cost, at the city of Mexico, about fifty per cent more than the same style in the United States. This, however, is modified by the climate, which requires no change of fashions to suit the seasons, as the same outfit is equally appropriate for every month in the year."—(*Strother.*)

Imported articles of food are exceedingly high at retail at the city of Mexico. American hams, in canvas, forty to fifty cents per pound; American salmon, cans of one pound, one dollar; mackerel, eighteen to twenty-five cents each; codfish, twenty-five cents per pound; cheese, fifty to seventy-five cents. The industry of Mexican pottery, a handicraft exclusively, employs a great many laborers, but has no organization—every community, and almost every family, in the districts where the conditions for production are favorable, making its own wares, as iron, tin, and copper cooking utensils are almost unknown in the domestic life of the masses of the Mexican people. The Indian manufacturer packs his pottery into wicker crates, about two feet square and from five to six feet long, and starts to different portions of the country, on foot, with the crate on his back. Consul Lambert, of San Blas, states that he has known one "to travel more than two hundred and fifty miles to find a market, and dispose of his articles at prices varying from one and a half to twelve, and, in the case of large pieces, as high as eighteen cents; receiving, in the aggregate, for the sale of his cargo, from twelve to fifteen dollars."

The manufacture of leather is also one of the great industries of Mexico; but, with the exception of the sewing-machine, which has been largely introduced in this and other occupations, the product is exclusively one of handicraft. In a country where everybody rides who can, the saddlery business is especially important; and by general acknowledgment there are no better saddles made anywhere in the world than in Mexico; and yet the United States has for many years exported from twenty to thirty thousand dollars' worth of saddles annually to Mexico. The explanation is, that the mechanical appliances used in the United States for making the "trees," and for stamping, cutting, sewing, and ornamental stitching, enable the American manufacturers to pay an import duty of fifty-five per cent, and undersell the hand-product of the low price (but dear cost) Mexican artisan. Consul-General Sutton, of Matamoros, reports to the State Department, under date of July, 1885, that Mexican dealers send to the United States model saddle-trees and designs for trappings, and find it more profitable to have the major part of the work of saddle-making done there, than to do it all by the low-wage hand-labor of their own country.

In short, this condition of affairs in Mexico, in respect to wages and the cost of production, is in strict accord with what has been deduced within recent years from the experience of other countries; namely, that the only form of labor to which the term "pauper" has any significant or truthful application, is labor engaged in handicrafts as contradistinguished from machinery production; and that, where such handicraft or ignorant labor is employed in manufacturing, the final cost of its product, as represented by the amount of time required, or the number of persons called for in any given department,

must of necessity be high. Hence, wages under such circumstances (as exist in Mexico and elsewhere) will be very low, and the conditions of life very unsatisfactory and debasing.

On the other hand, when machinery is intelligently applied for the conversion or elaboration of comparatively cheap crude materials —coal, ores, metals, fibers, wood, and the like—a very little manual labor goes a great way, and production (as in the United States) is necessarily large. This being sold in the great commerce of the world, gives large returns, and the wages represented in such production will be high, because the cost of the product measured in terms of labor is low, and the employer is thereby enabled to pay liberally; and in fact is obliged to do so, in order to obtain under the new order of things what is really the cheapest (in the sense of the most efficient) labor. Or, to state this proposition more briefly, the invariable concomitant of high wages and the skillful use of machinery is a low cost of production and a large consumption.

The following circumstance curiously illustrates the prevailing low money rate of wages in Mexico, and the obstacle which such cheap labor interposes to the attainment of large production: At one point on the Mexican Central Railroad, while journeying south, a machine, the motive-power of which was steam, for pumping water into tanks for the supply of the locomotives, was noticed, and commented upon for its compactness and effectiveness. On the return journey, this machinery was no longer in use; but a man, working an ordinary pump, had been substituted. The explanation given was, that with hand-labor costing but little more than the (Colorado) coal consumed, the continued employment of an engine and an American engineer was not economical.

But at no point within the observation of the writer, either on the Continent of North America or in Europe, do wages, or rather remuneration for regular labor, reach so low a figure as at Santa Fé, within the Territories of the United States. At this place, one of the notable industrial occupations is the transport and sale of wood for use as fuel. The standard price for so much as can be properly loaded upon a donkey (or *burro*) is fifty cents. The money price of the wood is high: but, as it is brought from a distance of fifteen, twenty, thirty, or even more miles, each load may be fairly considered as representing the exclusive service of a donkey for two days—going, returning, and waiting for a purchaser—and the services or labor of an able-bodied man, as owner or attendant, apportioned to from three to five donkeys for a corresponding length of time. The gross earnings of man and donkey can not, therefore, well be in excess of twenty-five cents per day; from which, if anything is to be deducted for the original cost of the wood, its collection and preparation, and for the subsistence of the man and beast, the *net* profit will hardly be appreciable. Or, in other words, able-bodied men, with animals, are willing to work, and

work laboriously, at Santa Fé, in the United States, for simple subsistence; and a subsistence, furthermore, inferior in quality and quantity to the rations generally given to acknowledged paupers in most American poor-houses; and yet no high-priced laborer in the United States has any more fear of the industrial competition of the pauper laborers of Santa Fé than he has of the competition of the paupers who are the objects of charitable support in his own immediate locality.

The largest, best-conducted, and most profitable of the cotton-factories of Mexico, and the largest manufacturing establishment in the country, is the "Hercules" mill, located near Querétaro, 152 miles from the capital. Taking a tramway, with comfortable cars of New York (Stevenson's) construction, for a distance of about three miles from the plaza, the visitor, on approaching, finds an establishment, embracing several acres, entirely surrounded by a massive, high, and thick wall, with gateways well adapted for defense and exclusion. On entering, the objects which first arrest attention are an attractive little park, with semi-tropical trees and shrubs; handsome residences for the owner and his family, and a stone armory or guard-house—with men in semi-military costume lounging about—containing a complete military equipment for thirty-seven men, horse and foot—Winchester rifles and two small pieces of artillery. Without being too inquisitive, the visitors are given to understand that all this military preparation was formerly more necessary than at present; but that even now it was prudent for the officers or agents of the mill to have an armed escort in making collections, contingent upon the sale of its products, from the country dealers and shopkeepers. Back of the guard-house were the mill-buildings proper, warehouses, stables, boiler-house, etc., all well arranged, of good stone construction, scrupulously clean, and in apparently excellent order.

The machinery equipment was 21,000 spindles and 700 looms; its product being a coarse, unbleached cotton fabric, adapted for the staple clothing of the masses, and known as "*manta.*" Both water- and steam-power were used. In the case of the former, a small stream, with a high fall, being utilized through an iron overshot-wheel, forty-six and a half feet in diameter—one of the largest ever constructed; for the latter a fine "Corliss" engine from Providence, Rhode Island. The spinning-frames and a part of the looms were from Paterson, New Jersey. The remainder of the looms, the steam-boilers, and the immense water-wheel, were of English workmanship. Wood, costing sixteen dollars per cord, was used for fuel; and the motive-power was in charge of a Yankee engineer, who had been induced to leave the Brooklyn (New York) water-works, by a salary about double what he had received there; but who declared that nothing would induce him to remain beyond the term (two years) of his contract, which had nearly expired. The motives prompting to this conclusion were suggested by observing, on visiting his quarters

outside of the gates, that a revolver hung conveniently near the head of his iron bedstead, while another was suspended from the wall, in close proximity to the little table on which his meals were served ; and also by the following remark, called out by a suggestion from one of the visitors, that a rug on the hard, unattractive red-tile floors would seem to be desirable : "If you had to examine your bed every night, to see that a scorpion or centiped was not concealed in its coverings, the less of such things you had to turn over the better."

According to information furnished on inquiry, the hours of labor in this typical Mexican cotton-mill were as follows : "help" work from daylight until 9.30 P. M., going out a half-hour for breakfast at 9.30 A. M., and an hour for dinner, at 2 P. M. ; Saturday night the machinery runs later. The spinners earn from thirty-seven and a half to fifty cents per day ; weavers from six to seven dollars per week. On hearing these statements, one of the visiting party, more interested in humanitarianism than in manufactures or economics, involuntarily remarked, "Well, I wonder if they have got a God down in Mexico!" There were present at this visit and inspection a representative of one of the large cotton-factories at Fall River, and one of the best recognized authorities on mechanics and machinery, from Lowell, Massachusetts ; and the judgment of these experts, after taking all the facts into consideration, was, that if this Mexican cotton-factory, with all its advantages in the way of hours of labor and wages, were transferred to New England, it would, in place of realizing any profit, sink a hundred thousand dollars per annum. And yet the proprietor of this mill (Don Rubio) and his family are reputed to be among the richest people in Mexico.

The adoption of the theory of "free trade," or "protection," as the basis of a national fiscal policy, does not appear to have as yet interested, to any extent, either the Government or the people of Mexico ; and it is doubtful whether, since the country achieved its independence from Spain, it has ever been seriously discussed or considered by anybody. Under the tariff act in force in 1882, there were one hundred and four specifications of articles which could be imported free of duty—including vessels of all kinds, machinery, and most railroad equipments and cars—and eleven hundred and twenty-nine specifications of articles subject to duties, nearly all of which (only thirty-two exceptions) are simple and specific. No other rule seems to have been recognized and followed in imposing duties on imports than that "the higher the duty (or tax) the greater will be the accruing revenue" ; and the *ad valorem* equivalents of many of the apparently simple and moderate duties levied on imports into Mexico are consequently so excessive that the average rate of the Mexican tariff is probably greater than that adopted at present by any other civilized country. All domestic manufacturing industries that could be exposed to foreign competition—as, for example, the

comparatively few cotton and paper mills, and one or two (calico) print-works—accordingly enjoy a degree of protection that nearly or quite amounts to prohibition of all competitive *legitimate* imports; though it may be doubted whether the fiscal officers who advised or determined such rates had any knowledge or care for any economic theory, but they may have been, and probably were, influenced in their conclusions by the representations of interested parties. But, be this as it may, the practical working of such a tariff, in such a poor, undeveloped country as Mexico, is well illustrated by a recurrence to Don Rubio and his cotton-mill. The average fabric produced at this establishment is protected by a duty on similar imports of nine cents per square metre, or about eight cents per square yard, and sells for about fifteen cents per *vara*, or thirty-three inches. Domestic industry is thereby promoted, and the family of Don Rubio amass great wealth.

But let us look at the other side of this picture. The number of operatives who obtain opportunities for employment by reason of the existence of cotton manufacturing in Mexico is probably not more than six or eight thousand, certainly not in excess of ten thousand. The population of Mexico, to whom cotton-cloth is the chief and essential material for clothing, may be estimated at ten million. Free from all tariff restrictions, the factories of Fall River, in Massachusetts, could sell in Mexico at a profit a cotton fabric as good as, or better than, that produced and sold by the factory at Querétaro, for five cents a yard, or even less. A population of ten million, poor almost beyond conception, have therefore to pay from two to three hundred per cent more for the staple material of their simple clothing than needs be, in order that some other eight or ten thousand of their fellow-citizens—men and women—may have the privilege of exhaustively working from fourteen to fifteen hours a day in a factory, for the small pittance of from thirty-five to seventy cents, and defraying the cost of their own subsistence. Nor is this all. Under such excessive duties as now prevail, few or no cheap coarse cotton fabrics are legitimately imported into Mexico, and the Government fails to get the revenue it so much needs. The business of smuggling is, however, greatly encouraged, and all along the northern frontiers of Mexico has become so well organized and so profitable as to successfully defy the efforts of the Government to prevent it. On the shelves of the stores of all the Mexican towns and cities, within two hundred and fifty to three hundred miles from the northern frontier, American cotton fabrics predominate. Five hundred miles farther "southing," however, seems to constitute an insuperable obstacle to the smuggler, and similar goods of English and French manufacture almost entirely replace at such points the American products. The present loss to the Mexican Government from smuggling along its northern frontier has been recently estimated by the "Mexican Financier" at not less than $1,500,000

per annum—a matter not a little serious in the present condition of Mexican finances; while all intelligent merchants along the frontier are of the opinion that neither the United States nor the Mexican Treasury officials can, by reason of this great illicit traffic, have any accurate knowledge of the amount of international trade between the two countries.

But if the present Mexican tariff on the import of foreign cotton fabrics were to be materially reduced, or abolished, would not, it may be asked, the cotton-factories of Mexico be obliged to suspend operations? Undoubtedly they would; but who, save the rich Don Rubio and his few associate manufacturers, would thereby experience any detriment? The Mexican people would continue to have cotton-cloth the same as now, and probably in greater abundance; for there is no other so cheap and suitable material available to them for clothing. But as the American and European manufacturers would not make their cloth a gift, or part with it for nothing, the Mexican would be obliged to buy it; or, what is the same thing, give some product of his labor in exchange for it. Consequently, the opportunity for the profitable employment of the Mexican people as a whole could not be restricted, if, in consequence of the abolition of the existing tariff on the import of cotton fabrics, they were relieved from an exorbitant and unnecessary enhancement of the cost of their clothing.

Mines and Mining.—The mining for the precious metals, and more especially for silver, has been, since the conquest of the country, and is now, one of the great industries of Mexico. That the product and profit of silver-mining in the past have been very great is certain; that a considerable number of mines are yet worked to a profit, and that future mines of great value will be discovered in the future, is also altogether probable. The popular ideas concerning the amount of the precious metals that have been furnished by the Mexican mines since the discovery and conquest of the country by the Spaniards, and the present annual product of gold and silver by Mexico, are, doubtless, a good deal exaggerated. The coinage records since the establishment of mints in Mexico, in 1537, down to 1883–'84, which are accepted as substantially accurate, and which indicate approximately the value of precious metals produced by the country during this period, are as follows:

From 1537 to 1821 (the last year of the Spanish colonial epoch), gold, $68,778,411; silver, $2,082,260,656; total, $2,151,039,067.

From 1822–'23 to June 30, 1884, gold, $45,605,793; silver, $1,023,-718,366; total, $1,069,324,159. At the present time the annual product of gold and silver in the United States is far greater than that of Mexico. Thus, for the year 1883 the gold production of the United States was estimated to have been, gold, $30,000,000; silver, $46,200,000; total, $76,200,000. For Mexico, the estimates for the year 1883–'84 were, gold, $500,000; silver, $24,000,000; total, $24,500,000.

The greatest obstacle in the way of the successful prosecution and development of the mining industry of Mexico, as also in the case of manufactures, is the scarcity of fuel and water for the generation and application of mechanical power. The impression which an American visitor to one of the great Mexican silver-mines, or reducing-works, at first receives, is almost always that of surprise at the apparent rudeness and shiftlessness of the methods of working. But a further acquaintance soon satisfies him that what is done is the result of long experience, and is the best that probably could be under all the circumstances. Thus, for example, for the purpose of extracting the silver from the ore by amalgamation, the rock, ground to a fine powder and made into a paste with water, is spread out on the floor of a large court, and then worked up, with certain proportions of common salt, sulphate of iron, and quicksilver into a vast mud-pie, by means of troops of broken-down horses or donkeys, which for two or three weeks in succession tramp round and round in the mass—animals and Indian drivers alike sinking leg-deep in the paste at every movement. When the amalgamation is completed, it is brought in vessels or baskets, rather than with wheelbarrows, to washing-tanks, where half-naked men and boys further "puddle" it until the metal falls to the bottom, and the refuse runs away. The process is hard, and even cruel, for both man and beast, and is not expeditious ; but it is economical (considered in reference to the cost of other methods involving power), and is effective.

The number of mining properties at present worked in Mexico by American companies is understood to be about forty.

The popular idea that there are a considerable number of old Spanish mines in Mexico which were worked to great profit before the revolution, and then abandoned when their original proprietors were driven from the country, and are now ready to return great profits to whoever will rediscover and reopen them, has probably very little foundation in fact. Sixty-five years have now elapsed since Mexico achieved her independence, and during all this time the Mexicans, who are good miners, and to whom mining has to a certain extent the attractiveness of lottery ventures, have, we may be sure, shrewdly prospected the whole country and have not concealed any of its business opportunities. Capital, furthermore, has not been wanting to them. For, in the early days of the independence of the republic, the idea that the working of old Spanish mines in Mexico promised great profits, amounted to almost a "craze" in England; and millions on millions of British capital were poured into the country for such objects ; while the mining districts of Cornwall were said to have been half depopulated, through the drain on their skilled workmen to serve in the new enterprises. It is sufficient to say that the results were terribly disastrous.

Silver Monometallism.—Until within a very recent period, Mexico has furnished to the world a most curious and interesting example of

a somewhat populous country conducting its exchanges almost exclusively by means of a monometallic, silver currency; no other form of money, with the exception of a small copper coinage, being practically used or recognized. The results were most instructive. Thus, if one proposed to trade, even to a retail extent, or go on a journey, a bag of coin had to be carried. If it were proposed to pay out a hundred dollars, the weight of the bag would be five and a half pounds; if two hundred dollars, eleven pounds; if five hundred, twenty-seven pounds. Where collections or payments were to be large, and the distance to be traversed considerable, regular organizations of armed men, and suitably equipped animals—known as "*conductas*"—were permanently maintained; and severe and bloody fights with bandits were of common occurrence. At the great cotton-mill at Querétaro, as already noted, the organization of a "*conducta*"—men, arms, and horses—for making collections, was as much an essential of the business as the looms and the spindles. "It was obviously impossible to carry even a moderate amount of such money with any concealment, or to carry it at all with any comfort; and the unavoidable exhibition of it, held in laps, chinking in trunks or boxes, standing in bags, and poured out in streams at the banks and commercial houses, was one of the features of life in Mexico," and undoubtedly constituted a standing temptation for robbery. Within a comparatively recent time, however, a national bank and banks of foreign incorporators have been established in Mexico, and authorized to issue notes, on what appears to be very inefficient security. The Mexican National Bank is understood to be authorized to issue $60,000,000 notes upon a capital of $20,000,000, which notes are legal tender from individuals to the Government, but not from the Government to individuals, or between individuals. The possibilities, if not probabilities, therefore, now are, that a flood of depreciated paper will ultimately drive silver out of circulation in Mexico.

WHAT MAY ANIMALS BE TAUGHT?

By M. J. DELBŒUF.

"THERE exists in animals," says Malebranche, "neither mind nor soul as we commonly understand the terms. They eat without pleasure, they cry out without pain, they grow without knowing it, they desire nothing, they know nothing, and, if they behave in a manner betokening intelligence, it is because God, who made them, has, to preserve them, formed their bodies in such a way that they avoid mechanically and without fear everything that is capable of destroying them." Malebranche was more categorical than Descartes on the subject of soul in beasts. The latter had doubts on the matter. He

would not have been far from conceding thought to the higher animals. But then he would have had to concede it to all, even to the oyster and the sponge; and what have the oyster and the sponge that resembles a soul?

We know how this question occupied the seventeenth and eighteenth centuries. In the nineteenth century, Frédéric Cuvier, Flourens, and others took it up, and tried to establish upon facts a distinction between intelligence and instinct. Finally, Darwin came and wiped out every line of demarkation between man and animals. But, whatever may be the favor—rapidly gained—that surrounds the doctrine of transformism, we must not forget, on the one hand, that it is not universally accepted, nor on the other hand, that it does not answer the question of the intelligence of animals.

The great physiologist Schwann, for instance, who died in 1882, maintained that there was an insurmountable barrier between us and those whom Michelet calls our inferior brethren. To him animals were alembics and electric batteries; mechanics, physics, and chemistry could account for all their manifestations. Man alone contained an immaterial principle, the freedom of which constitutes his characteristic appanage. That is what he distinctly declared on that day when the European great men of science came to Liége with an ovation to the illustrious creator of the cellular theory, on the fortieth anniversary of his professorship. "By virtue of the cellular theory," he said, "we now know that a vital force, fundamentally distinct from matter, exists neither in the organism as a whole nor in every cell. All the phenomena of animal and vegetable life can be explained by the properties of atoms, which are the forces of inert nature, or by other forces of the same atoms hitherto unknown. Freedom alone establishes a limit at which the explanation by forces of this kind must necessarily stop. It obliges us to admit only in man a principle that is incompatible with the properties of matter."

To Schwann, as to Malebranche, the animal was an automaton. It is true that he did not regard it as a mechanism moved by an internal or external spring; it was an aggregation of atoms combined in a certain manner. On the other hand—and in this he was at variance with Descartes—it was not thought, but liberty which, in his eyes, constituted the distinctive attribute of man. But essentially, to him as to the pure Cartesians, man was an animal inhabited by a spiritual substance—a substance distinct from matter. I learned, however, from conversations I had with him on the subject, that he did not deny to animals the faculty of feeling pleasure and pain, memory, intelligence, and a certain amount of reason. In this he wandered essentially from Cartesianism, for in it he accorded thought to matter.

From the exclusively logical point of view, Cartesianism is impregnable. Animals do not feel or reason, but have only the appearance of doing so. From the same point of view Schwann's system is

also impregnable. Animals feel and reason, but have not the power of deciding for themselves. From the point of view of feeling or common sense, the latter system is much more acceptable than the other. It may even be said that it satisfies the mind and the heart, and imposes no hindrance to scientific research. This has also been proved by Schwann's own example. But it is not less certainly irreconcilable with transformist theories of the descent of man; by it man should have a place apart in Nature.

The stories that have been recently published and held up to attention, as illustrations of the intelligence of animals, have really no bearing unless they indicate that animal intelligence is comparable to ours, in the sense that a passage may take place from one to the other by insensible degrees. Otherwise there would be no need of the demonstration; and Schwann as well as Darwin, Malebranche as well as Descartes, might subscribe to it; for we might say that, in a certain sense, a mechanism is intelligent.

Now, there are some facts that bear against the assimilation of the two kinds of intelligence. An infant, which in the beginning seems less intelligent than a young puppy, very early manifests its superiority; and one of the first things it learns is that which can not with any amount of attention be taught to a dog. It is the capacity of our race for improvement in contrast with the immobility that seems to attach to animal races. Need we, to illustrate this, speak of machines and tools, writing, and the fine arts? It is true that there are monkeys that can defend themselves with sticks and pebbles; fish that can throw up drops of water to stun the insects they want to swallow; and birds that can embellish their nests and form parterres of flowers which they will keep fresh. But these curious stories are not enough to close the discussion. Moreover, however similar these acts may appear in a material sense, they must not always be regarded as mentally alike. When my dog, at my order, brings my slippers or letters, he does not act with the same mind as a servant.

Indeed, the assimilation is sometimes justifiable. I had occasion in some articles that appeared in the "Revue Philosophique," on Mr. G. H. Lewes's last book (March and April, 1881), to relate a number of stories in which insects, mollusks, and hydras, as well as dogs, behaved, under particular circumstances, as a man would. Let me repeat one of them: "I was in the habit of giving bones to my poodle Mouston during dinner, and he would go into the yard to gnaw them. When the bone was too large for him, I would get up and go out with him, and split it before his eyes with a hatchet. One day, Mouston, after having gone out with his bone as usual, came back bringing it in his mouth, fixed himself in front of me and wagged his tail. I ordered him back, but he persisted in staying where he was. Finally, I thought of what he wanted and arose, while the animal indulged himself in leaps of satisfaction. The trouble was, that the bone was

too large for him. Now, when I call to mind the expression of the dog when he showed me the bone without getting an answer from me, I could not help thinking that he must at that moment have had a very poor opinion of my understanding."

It is evident from this incident that Mouston knew explicitly that the bone would be easier to manage if it was split, and that I alone had means of splitting it; and he had a clear and precise idea in anticipation of what he expected from me. Finally, he manifested his desire to me by the only means within his power. How much better could a deaf-mute do than he did?

But it is one thing to think by resemblances, and another thing to think by symbols. A story was recently published by M. Dubuc, of a pointer which had learned after a few years that its master went hunting every Sunday, while on the other days he went to business; and M. Dubuc concluded that the animal had learned to count up to seven.

This conclusion is not legitimate; it may even be said to be wrong. The dog distinguished Sunday by some features that were peculiar to it; by the movements about the house, the behavior and Sunday dress of the servants, the dress of the master, or any one or more of a number of things that make Sunday different from the other days of the week; but we may say without contradiction that it did not count seven. We ourselves, if we were restricted to a life absolutely uniform, would not be able to distinguish the seventh day without mnemotechnic aids, and as a rule we seldom recollect the day or the date except by the assistance of intrinsic circumstances.

My dog, which was habitually on the watch, perfectly understood whether I was going out to my lectures or for a stroll. For some time, he went with me to the university, when I sent him back. But he very soon took in the signs characteristic of the days and hours when I went to my duty—the regularity, my breakfast habit, my dress, the books under my arm, the direction I took, and my thoughtful air. We all know how observing animals are, and every one who has a dog has remarked how readily they learn that they are to be invited to go with us.

My Mouston was a great vagabond. He would go off in the morning as soon as the door was opened, and would sometimes not return till evening; but if I said to him, "Mouston, we are going to take a walk," he would stay around the house and watch my every motion.

The fondness of dogs for going walking with their masters is worthy of remark. The three dogs I had had the freedom of the street, but it was a great treat to them all to go with me. Probably the pleasure of coming up every once in a while to smell their master's legs goes a great way to compensate them for the restraint of following a fixed road and the often-repeated annoyance of the sudden interruption of interesting conversations that have hardly been

begun. We also know how quickly animals acquire the idea of the time of day. Sparrows know when it is time for the bread to be thrown out for them, and collect around the spot at that hour. Lacépède tells of a toad which used to come out of its hole at the time it was accustomed to be fed. I had a lizard that would leave its nest and climb up my sleeve at dinner-time. Persons of my age, in Liége, used to be acquainted with a vagabond dog that regularly at the same hour made the round of the *cafés* for the bones or the lumps of sugar which he was sure to receive from his friends there; and would as regularly every evening go to his sleeping-place under a particular gateway. This animal evidently perceived the time of day by certain signs that had been taught him by observation; and M. Dubuc's dog knew when it was Sunday, or hunting-day, by the same means. And if, on some Saturday, the house had been arranged and the household had managed to behave in the manner usual to Sunday, the dog too would have been found all prepared for his anticipated hunting excursion, just as if it had not been one day short of his accustomed seven.

This faculty of attentive observation of dogs may be stretched so far as to deceive an experimenter who is a little prepossessed on the subject.

In his paper before the British Association at Aberdeen, Sir John Lubbock related how Mr. Huggins, having arranged cards bearing the ten ciphers, gave his dog a problem, such as to give the square root of nine, or of sixteen, or the sum of two numbers. He would then touch each card in succession, and the dog would make a sound to inform his master when he came to the right one. The dog was always right. The secret of the experiment was that Mr. Huggins unconsciously informed the dog by his attitude when he came to the card that gave the answer. Sir John Lubbock tried to train his dog not to take a piece of bread till he had counted seven; but when he used a metronome the dog showed that he was lost. I made analogous and systematic experiments with my Mouston. They extended to the number four, and I aimed to make the sign of the number more and more indistinct, on each repetition of the experiment. As soon as it was quite effaced, the dog lost his knowledge of it, and his perplexed and inquiring look was amusing.

Sir John Lubbock mentions that Lichtenberg pretended to have a nightingale that could count three. Every day he gave it three meal-maggots, one at a time, and the bird never came back after it had got the third. This observation is very interesting, but we ought to know whether the nightingale did not perceive by some sign that the meal was over. I have no doubt that, if, in the experiments which I have made on siskins and gold-finches, I had had only three grains of hemp-seed in my mouth, they would not have returned after having taken the third seed, or at least would have been likely not to return; but in fact I had many grains, and I frightened them away when they had

got three. My experiments were not brought to a conclusion, but, if they had been, it would not have been right to assume too readily that the birds knew how to count. We should have to inquire whether I had not involuntarily made some sign manifesting my intention. The remarkable experiments of Mr. Cumberland have revealed to us a whole category of motions of this kind which had never been taken account of before. Who, previous to him, would have suspected that the hand trembles in a different way when we think of seven and when we think of three?

The solution is not advanced, then, when we tell of the cases, curious and interesting as they may be, in which animals seem to behave like man; or, to speak more exactly, these cases are proof only with respect to persons who are inclined to attribute instincts alone to the animal, and deny it reflection and calculation. As the philosophers are still at this point, it may be well to try to undeceive them. *Mutatis mutandis*, the spider chooses the place for its web, and the bird for its nest, as the colonist selects the location of his farm-house, or of the pen for his goat or pig. I will agree that we may regard the laying of the eggs, the making and shaping of the nest, and the selection of materials as instinctive acts; but the selection of the place is necessarily of a deliberate and intelligent character.

If there is a difference between animal and human intelligence, it depends upon special causes, and these are what we are trying to disentangle. I have already remarked that man has the faculty of thinking by symbols, while the animal appears not to have it. What is a symbol? It is not easy to define the term. Let us say provisionally that it is a conventional mental sign, representing a clear abstraction. The definition is neither very good nor very clear, but it will do, for want of a better one. Before Thales and Pythagoras, thinkers had distinguished between the common idea and the concept. The common idea is formed within us, we may say, almost physiologically. Take, for example, the idea of horse. When I have seen twenty horses, I have seen for twenty times the qualities which they all have in common, while I have seen for a less number of times, or only once, their respective individual qualities; so that the common image engraves itself in the brain or in the *sensorium*, if that term is preferred, in deeper and deeper lines and stands out strongly at the base of the particular and fugitive images.

The concept partakes of the common idea, and it might perhaps be maintained that it is formed within us in the same manner. But the degree of abstraction which it necessitates is infinitely more considerable. Let it be, for example, the number four. We agree, it is true, that the idea of, say, any group of four fingers of the hand is a kind of common idea; but it is a good way from this idea, from this kind of group, to that of four distant and different objects, like the four limbs, the four largest cities in the world, the first four Roman em-

perors, or the four largest fruits. But this is not all. The number four is still easy to transform into images, but that is no longer the case when we come to higher numbers, such as seven, and, with still more reason, 20, 100, 1,000, etc. Yet the large numbers are not more difficult for us to conceive than the small ones. This is because we represent them by conventional signs, or the figures.

We must not, however, forget that some savage peoples can not count beyond four or five. Sir John Lubbock tells in his paper an anecdote of Mr. Galton, who, on one occasion, made a comparison of the arithmetical comprehension of a Damara savage of South Africa and a little dog. According to Mr. Galton, the comparison was not to the advantage of the man.

Let us now examine Sir John Lubbock's experiments. He wrote on his cards such words as *go*, *bone*, *water*, *food*, etc., in phonetic orthography, so as not to trouble his dog's head with the difficulties of English spelling; also words without significance to the animal, such as *simple*, *nothing*, *ball*, etc.; and he had cards with nothing written on them.

Van—the dog—soon learned to distinguish the blank cards from the written ones; then he learned to attach an idea to some of the latter; and finally was able to fetch to his master the card that corresponded with his wish. To get a single meal he had to fetch some eighteen or twenty of these cards, and he made no mistakes.

Sir John Lubbock concluded from this success that Van had learned to read. In one sense, this conclusion is absolutely false, but that is not the sense in which Sir John regarded the matter. In another sense it was true, and this is the point on which we need light.

There was never a dog whose master has not said and thought a thousand times that he only lacked speech. In fact, the dog seems to comprehend speech, and speaks in his expression. His eyes—behind which, according to Madame de Staël's fine expression, he seems to conceal a human soul—interrogate, supplicate, and answer; his ears are erected, or lop over; his tail wags, and his whole body assumes marked attitudes, not to be misinterpreted, of desire, joy, attention, anger, repentance, fear, shame, and submission. Could he better express all of his feelings if he spoke? Should we understand him any better if he should say to us when he had been guilty of some misdeed, "I deserve to be punished, but don't, I pray you, be too hard on me," or if, after he had been corrected, he should politely thank us for our moderation? We perceive at once the distance between his language and ours. One is natural, the other conventional.

Does he understand our conventional language? He does, and he does not, but in the more exact sense he certainly does not. He understands us when we give him our usual orders: "Down!" "Come here!" "Go back!" "Give me your paw!" "Now, the other one!" "Seek it!" "Bring it here!" "Get out!" But we forget that

we accompany our interjections with corresponding gestures, and that the interjection itself is only one gesture more. We forget how we have trained him, how we have worked upon his instinct to make him run for the stick we have thrown, and have taught him to bring it back in his jaws, by leading him, and showing him how, and petting him when he performs the trick aright. You accompany your orders with certain words as if you were speaking to a child, and gave them a precise signification ; but the dog does not attach this signification to the word only ; to him the word, or the vowel in the word, is only a sign that concurs with all the others in helping to make him understand what we want of him.

If, while sitting at my table, I say to my son, "Charles, will you be so good as to bring me my slippers ?" he will understand me. If I say the same thing to my dog, in the same tone and without moving, he will not understand me. I shall have to express myself in a particular manner and a particular tone of voice. He will understand, "Mouston, bring the slippers !" or "Mouston, slippers !" or "Mouston, bring !" But he will not understand the cool, calm request that is sufficient direction to my boy. The word *slippers* does not call up in him the idea of my slippers, but that of a complex action which he is to perform, consisting of a combination of successive movements winding up with a caress. Provided I make the accustomed gesture, he will obey, though I use the wrong word ; and he will not obey, though I use the right word, if I speak in an indifferent tone as if to some one behind the scenes.

It frequently occurs to us to think in this way by sensible images, although we do not remark it. When in the morning I hear the servants go down, make the fire, and arrange the table, hear the rattling of the dishes, I do not think in words that they are getting breakfast, and are preparing the coffee, and putting on the bread, and the butter, and the sugar ; but I see these preparations in images ; I behold the coffee-pot, the milk-pitcher, the sugar-bowl and sugar, and the slices of bread ; and I see in my mind's eye the housemaid in her white apron going back and forth, opening the cupboards, and arranging the table-service. When, after this, she knocks at my door, and calls out, "Breakfast is ready, sir," it is very possible that these words will not awaken in my mind the idea of breakfast, but that of time to get up, to wash, dress, and go to business. I attach to the words, with their strict sense, a more remote sense which is associated with them. This is the way dogs and animals generally think ; and this is the meaning our language has to them. They do not analyze, but comprehend in block. This is the way the deaf-mute comprehends our signs.

It surely is not by analysis that the child learns to speak ; he understands our phrases as a whole, and it is not till after some time that he comes to see in them separate words ; but, finally, he decomposes the phrases. Now, if the child can do this, why can not the ani-

mal do it too? Because the animal does not, and the child does speak. The child speaks whenever it gives utterance to its desire or feeling. The dog does not speak, when, knowing that he deserves correction, he comes up, timidly and abjectly, to cringe at the feet of his master. It is voluntarily, that is, after having found out the how and the why, that the child has associated certain movements of the larynx with certain ideas. But you can not teach a dog to come up for correction gamboling and wagging his tail.

The deaf-mute comprehends and speaks to himself in reading writing. He speaks to you when he writes to you, because the voluntary and trained movement of his eyes or fingers has put on for him a precise signification. The parrot would be speaking if he said, "Let us have breakfast" whenever he wanted to eat; but he does not speak when he amuses himself by hailing every visitor with these words.

To return to Sir John Lubbock's dog, he speaks when he goes deliberately to look for the card which corresponds with his desire; we might perhaps say that he reads, for he distinguishes it among the others. Only, the sign might be a triangle or a square, a round figure or a dart; the result would be the same, and would have no bearing. Sir John's idea of phonetic writing has an air of whimsicality; and I am inclined to believe it must have been sportive, and that the secret of the matter lay in the simplification of the figure of which the dog had to grasp the meaning.

The question now arises whether we can hope to go much further with the animal. It is one of the most important questions in the discussion. After all, if the transformist doctrine is true, and there was an ancestor of man that did not know how to speak, and man has had to learn to speak, why may not the dog do the same? Professor P. J. Van Beneden, of the University of Louvain, had, and may still have, a dog which could accompany with his voice a tolerably complicated air played on the piano. My dog Marquis could sing in unison an air of "La Favorita" when a contralto friend gave him the key-note. Could we not get him to give some signification to his vowels? Possibly, but it would be a very hard task, for these reasons:

We speak and we write and read with the eyes. The blind man reads with his fingers and writes; the deaf-mute reads with his eyes, and he writes and even speaks without hearing. Language, under whatever form it is manifested, consists essentially of a series of voluntary and conscious movements, at least in the beginning (I mean reading with the eyes), to which we attach a certain meaning. These movements are of the most various and complicated character. The organs which produce them are either the vocal apparatus, exceedingly mobile and susceptible of assuming a great variety of figures, which includes the larynx, glottis, palate, cheeks, tongue, teeth, lips, and nose, or the fingers placed at the end of the arms, capable of various movements, or the eyes. The dog has neither our larynx nor

hands; there remain to him only the eyes. He can not, then, learn to speak or to write. Could we teach him to read; and to what extent? The question comes back in a manner to this: Could we teach an armless mute, not deaf, to read? I think it would be a more formidable task than was that of teaching Laura Bridgman.

Under the old way it was very hard to teach children to read, even with the help of hearing, the sight, and the voice. We showed them the letter A, pronounced it, and made them repeat it; then we passed to the letter E, and so on. At the end of a year the most intelligent, at the end of two years less bright, ones were able to attach a determined sound to certain shapes, that is, when we bring it down to the final analysis, to certain conscious motions of the eyes. After that we taught them writing.

Not a great while ago a pedagogue was struck with an inspiration of genius. It occurred to him to teach reading and writing together. At first sight it seemed absurd to think of simplifying reading by adding writing to it. But what was the outcome of his plan? Why, that now, children, in the course of three months, and with much less difficulty and without help from the application of the ruler to their fingers, learn to read and write with much greater facility and correctness than they formerly could in three years.

This comes from the fact that the motions of the hand are associated with those of the eyes, and the form of the letters is thus engraved upon the memory by means of two different instruments, and therefore much more quickly, one assisting the other; and because the other associations of prolonged sound and articulate sound with that form have become surer and more rapid.

Would it be possible, by showing him the letter A, to make a mute, not deaf but armless, understand that the sign corresponds with a sound? Evidently the experiment would not succeed. We might with patience teach him to kneel, to get up, to walk, or to make certain gestures as we show him certain figures. We could do this with the mute more easily than with the dog, because we could exemplify the movement to him, and because also, imperfect as he is, he is a man and not a brute. He would also attach the same meaning to the pronounced sound, and would thus learn that the written sign A answers exactly to the sound A, as he would obey orders given by the voice, and we would be able to say that he understood language. He might also, if we put the alphabet at his command, manifest his wishes by indicating the sign corresponding with them, and we might be able to say that he had a language. Possibly we might be able to go further still, and train him to the point of interpreting the design; but I do not hazard much in saying that his education would still leave an enormous amount to be desired. It is very hard to make a great scholar even out of a deaf-mute who has arms and has learned to speak, and Sandersons are exceedingly rare.

But would the dog ever accomplish much more than to attach a kind of concrete significance to the figures of the letters; than to associate his necessities or his natural or artificial wants with them? It is very doubtful, and that is what is indicated by Sir John Lubbock's experiments:

Sir John painted six cards, two blue, two red, and two yellow. Three of these were put before the dog, who was to bring his master the card of the color that was shown him. Although he was rewarded every time he succeeded, he never fairly understood what was wanted of him. This was because the action of bringing the card of the right color did not appeal directly enough to his senses. Sir John obtained no better result with six cards marked I, II, III, etc. Van never exactly grasped the conformity of the figures.

What was it prevented my dog, upon whom I tried experiments in numbers, grasping the difference between three and four pieces of meat? He failed because he had to abstract the ideas of the numbers 3 and 4 from the variety of the figures which were presented to him. I have no doubt he might in time have learned to distinguish the triangles from the squares which I formed on the plate with the three and the four pieces of meat. The thing that baffled the beast—we must not forget that the dog carries the faculty of observation to a considerable length—was the incessantly variable diversity of the figures. Under these circumstances, the problem was made too complicated for his head, those means only being given which I had prepared for entering into communication with his intelligence.

If any of the readers of these pages is tempted to teach a dog arithmetic, he would do well, I think, to begin by making him distinguish *one* from *two*, permitting him to touch only a single piece at the word *one*, and two pieces at the word *two*. Then he could pass on to three, and, if he went so far, to four. After that, he might essay addition: one and two, one and three, and two and three. The experiment would be very interesting and instructive, whatever the result might be. For, as Sir John Lubbock says, we ought not to aim for any one result rather than another, but for the truth.

Is the dog, after all, a suitable subject to experiment upon, in regard to the distance that separates man from animals? Would it not be better to select the monkey, intractable as he is, but formed like us, and not only able to imitate our gestures but fond of doing so? We might by this means attempt a verification of M. Noiré's seductive hypothesis respecting the origin of language: that it is the product of a social state already considerably advanced, and that the sounds, being at first simply utterances accompanying the movements of the whole, finally become the signs of those movements. But suppose, for a moment, that the dog acquires some notion of number, what are we to conclude from it? Is the advance of such a kind that it can be communicated to the whole species or to a particular breed? That would

be at least doubtful. There have been very serious and learned controversies respecting the possibility of the transmission by generation of acquired advantages. Weissmann decides the question in the negative. Only aptitudes are transmitted by descent. The discussion appears to be, to some extent, an affair of words. Some say pointer-dogs have been formed by hunters, who taught particular individuals not to chase after game, but only to signalize its presence, and that the knowledge of the fathers passed to their posterity. Others reply that this is not the case; even in the times of the corporations or trade-guilds the sons of shoemakers were not born shoemakers. Special aptitudes, manifested by particular individuals, have been turned to the best advantage; they have been cultivated, and thus breeds have been created by selection. I say that this is a question of words, because in any case the re-enforcement of the aptitude is something acquired, and this acquisition, it is admitted, passes to descendants.

Let us suppose, then, that we have created a race of calculating dogs. We might, by a bold but legitimate generalization, infer from that that all animals would be susceptible of acquiring abstract notions or of thinking by symbols. But the dog would have had an educator. Must man, then, also have had his educator? We see, thus, how this question would take shape, and it certainly would be no less grave or less perplexing than the alternative.

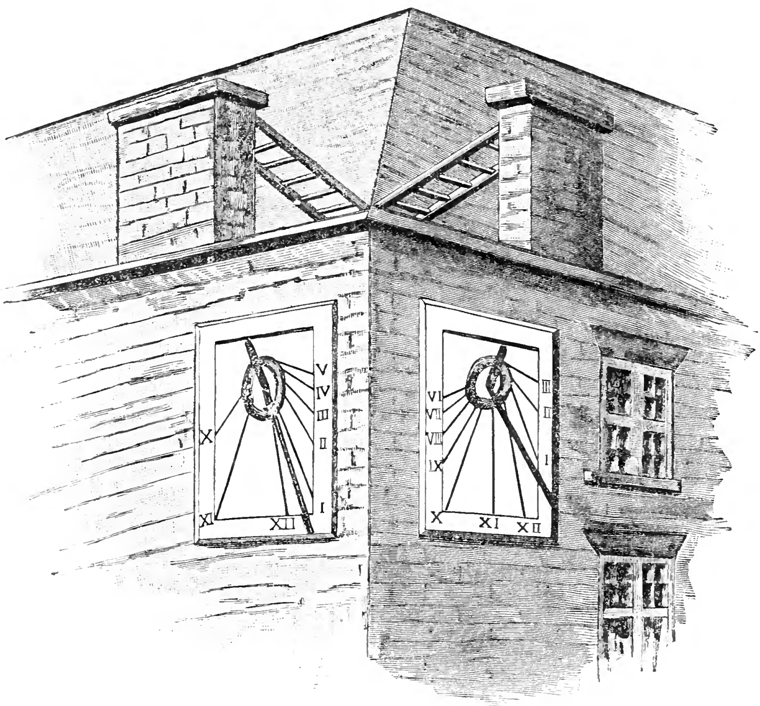
Again, let us suppose that the attempts utterly fail. We might, indeed, contend that the check was only a temporary one. But let us waive the evasion, and reason as though the dog were radically incapable of representing his thoughts by symbols. Would not absolute transformism, that is, the applicability of transformism to man, receive a mortal blow? I do not believe it. The only really legitimate conclusion would be, that not all species are indefinitely perfectible, but that only a few species, perhaps only one, have really entered upon the road to infinite progress, while the others have gone into a kind of blind alley. It is in the same way that the main stem of a tree may theoretically grow up indefinitely toward the sky, while the development of the lateral branches is necessarily limited by the power of the wood to resist rupture.

We thus see that this problem is one of an exceedingly interesting and tempting character. Although Malebranche has no partisans now, those who agree to some extent with Schwann form legions, and in their eyes transformism has only the value of a general doctrine. It is the question of the origin of man and his place in the world, which is raised by Sir John Lubbock's cards, and on which, with the co-operation of his dog Van, he has contributed to throw a little light. Anthropology also can only follow his experiments, the abortive ones as well as the successful ones, with legitimate curiosity, and return its most earnest thanks for them.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

PRIMITIVE CLOCKS.

By FREDERIC G. MATHER.

THE story is that King Alfred had no better way to tell the time than by burning twelve candles, each of which lasted two hours; and, when all the twelve were gone, another day had passed. Long before the time of Alfred, and long before the time of Christ, the shadow of the sun told the hour of the day, by means of a sun-dial. The old Chaldeans so placed a hollow hemisphere, with a bead in the center, that the shadow of the bead on the inner surface told the hour of the day. Other kinds of dials were afterward made with a tablet of wood or straight piece of metal. On the tablets were marked the different hours. When the shadow came to the mark *IX.*, it was nine o'clock in the morning. The dial was sometimes placed near the ground, or in towers or buildings. You see, in the picture, two sun-



dials that are on the Gray and Black Nunnery in Ottawa, the capital of Canada. The old clock on the eastern end of Faneuil Hall in Boston was formerly a dial of this kind; and on some of the old church-towers in England you may see them to-day. Aside from the kinds mentioned, the dials now in existence are intended more for ornament

than for use. In the days when dials were used, each one contained a motto of some kind, like these: "Time flies like the shadow"; or, "I tell no hours but those that are happy."

But the dial could be used only in the daytime; and, even then, it was worthless when the sun was covered with clouds. In order to measure the hours of the night as well as the hours of the day, the Greeks and Romans used the clepsydra, which means, "The water steals away." A large jar was filled with water, and a hole was made in the bottom through which the water could run. The glass, in those days, was not transparent. No one could see from the outside how much water had escaped. So there were made, on the inside, certain marks that told the hours as the water ran out; or else a stick with notches in the edge was dipped into the water, and the depth of what was left showed the hour. Sometimes the water dropped into another jar in which a block of wood was floating, the block rising as the hours went on. Once in a while, some very rich man had a clepsydra that sounded a musical note at every hour.

Another way of measuring time among the ancients was by the sand, or hour-glass. This was made of pear-shaped bits of hollow glass with a very small opening between them. It held just sand enough to run from the upper into the lower pear in the space of one hour. The glass was then turned the other side up and the sand ran back, also taking an hour. You have seen glasses of this kind where the sand runs out in three minutes. They are used for boiling eggs. King Charlemagne, a thousand years ago, had a glass of this kind that ran for twelve hours without turning. It was marked on the outside with red lines to show the escape of the sand. Hour-glasses were so common after this that they were carried in the pocket like watches. Every minister had one to mark the length of his sermon, which was a very serious matter in England during the protectorate of Cromwell, very few sermons being as short as one hour. It is said of one minister that when the sand ran out of his glass he turned it over, saying, "I know that you are all good fellows, so let's have another glass." Once, when the preacher had turned his glass a second time, showing that he had already preached two hours, the sexton asked him to lock the door and put the key on the nail when he was through, because the few people that were left wanted to go home to dinner. We also read that, in the early history of New York, the soldiers who defended the city used hour-glasses to tell when they should go on guard.

We have seen that the dial could be used neither at night nor in cloudy weather. We have also noticed that the hour-glass had to be watched so that it might be turned at the very moment the sand ran out. And we have also seen how inconvenient it was to measure time by the running of water. None of these ways was accurate enough, for minutes and even hours would be lost. A better means of measuring time was sought for; and this was found by means of a clepsydra,

in which the water drove a wheel that marked the hours by a hand. The old Romans used this water-clock; but, when their empire was destroyed, all Western Europe forgot the existence of such a thing. In the year 807 A. D., the Caliph of Bagdad, Haroun-al-Raschid, sent to Charlemagne a water-clock of this kind. Soon after we learn that, instead of the running water, a weight was used for turning the wheel. But whether the clock was run by water or by a weight it was always a hard matter to have the hours of the same length. The escapement, which we shall speak of presently, made one hour more nearly the length of every other hour. The machine for telling the hours was, for many years, called the horologe, or "hour-teller." The word "clock" was applied only to the bell that struck the hours. It sounds very much like the Saxon, French, and German words that mean "bell." About nine hundred years ago horologes were brought into England by the Catholic clergy. Very large horologes were built into the towers at Canterbury Cathedral, in 1292; at Westminster, in 1290; at Exeter Cathedral, in 1317—the striking part of which is still in use; at the cathedrals of Wells and Peterborough; and at St. Albans Abbey in 1326. A smaller horologe was made for Charles V of France in 1370, by a German named Vick.

Horologes, or clocks, would have remained in this imperfect state until to-day if it had not been for the invention of the pendulum, which means "something that swings." You all remember the story of Galileo, who, when a boy, watched the chandelier as it swung to and fro in the cathedral at Florence. The young boy noticed that it moved with great regularity. If it had moved all the way around the point where it was held, or suspended, it would have made a circle; but as it moved only a small part of the way, it moved in what is called the "arc" of a circle. Galileo saw that it took just as long a time to go from one end of the arc to the other as it did to return. This is called isochronism, or "equal times." In 1620, several years after Galileo's discovery, Huygens first used the pendulum to regulate the movement of a clock. You may see how this is done by looking at Fig. 1. We have here the simplest form of clock-work, or "movement," as it is called. A wheel, with teeth on the edge, turns on a pin, *i*, by the force of the weight *h*, the string being wound about what is called a "barrel" at *i*. If there is no way of stopping the wheel, it will run down very fast and very unevenly. Here is just where the pendulum becomes useful. The pendulum is a long wire, *a c*, the part *c* being enlarged into what is called a "bob." The pendulum swings on the point *a*. It has an arm, *d g*, fastened to it and swinging with it. The points of this arm are called the "pallets." When the pendulum is in the position marked by the black line you will see that the wheel is stopped by the pallet *d*. But, when the pendulum swings to the place marked by the dotted line, the pallet *d* moves out to *e*. This lets the wheel move a little; but, before it

moves a notch, the pallet *g* has moved to *f* and catches the wheel below. When the pendulum swings from *b* back to *c*, *f* is moved to *g*, and the pallet *d* stops the wheel from going any farther. So that, while the pendulum has gone from *c* to *b* and back again, only one tooth of the wheel has escaped instead of two. The arm of the pendulum which acts upon the teeth of the wheel and the wheel itself are called the "escapement," because they let only a little of the power in the weight escape at a time—just as the hour-glass allowed but a little of the sand to escape at once, and as the clepsydra allowed only a little of the water to run out at a time.

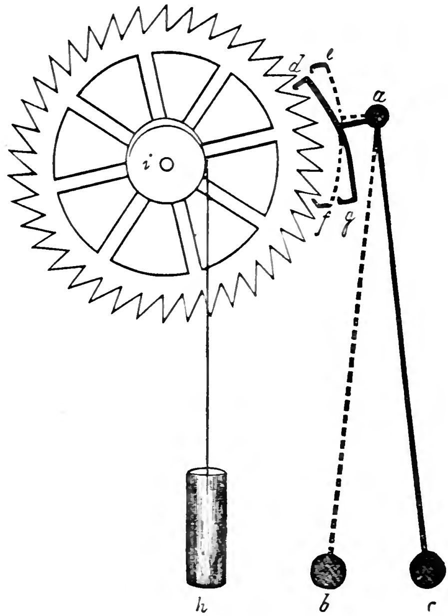


FIG. 1.

The earliest form of an escapement was that of Vick. It was a small wheel that was turned back and forth by a twisted string. Afterward it was turned by a spiral spring, the wheel being always horizontal, or running at right angles to the other wheels, that were vertical. A new "scape-wheel," as it is called, was invented by Dr. Hooke, which moved vertically, or in the same plane with the other wheels. This is the wheel that is shown in Fig. 1. You will see by the figure that, when the bob is at *b*, and the tooth of the wheel comes on the pallet *f*, it will throw *f* over to *g* and help the bob to move from *b* to *c*. This is called the "recoil" escapement, because the force of the wheel gives such a sudden jerk to the pendulum. The cheaper clocks frequently have the recoil escapement. Very much of this jerking motion is saved by the "dead-beat" escapement, invented by Graham, an Englishman. It is so called because the tooth of the wheel falls dead upon the pallet and stays there until the pendulum starts back and releases it. The teeth of the dead-beat scape-wheel are of a different shape from those shown in Figs. 1 and 2. The "gravity" escapement is so called because another weight beside the principal weight gives an impulse, or motion, to the pallet. There are many other kinds of escapements, that are too difficult to be explained here. I have described only the simpler kinds.

In Fig. 1 the pendulum is made very much shorter than it should be, so that it will not take up the whole of the page. At the earth's

equator it should be about thirty-nine inches long, to "vibrate," or go from *c* to *b* in one second. At the latitude of Washington, where the force of gravity is greater, the length is thirty-nine and one tenth inches. At London, which is still farther north, the length is thirty-nine and one seventh inches. A pendulum of the right length in London would lose two and one quarter minutes a day at the equator. The pendulum that vibrates from *c* to *b* in two seconds must be four times the length of a one-second pendulum. The pendulum of the great clock at Westminster moves once in two seconds. It is nearly fifteen feet long, and it weighs seven hundred pounds—the heaviest in the world. The heavier and longer the pendulum, the more regularly will the clock move. But pendulums may be too long and too heavy. Almost all of the clocks that were made before the year 1800 had pendulums about thirty-nine inches long, and they stood with their cases over five feet high—usually in the corner of the room. They were so clumsy that only the machinery was peddled about from place to place—the nearest cabinet-maker being called upon to make the case. By-and-by it was found that, if, in Fig. 1, the pendulum would go from *c* to *b* in one second, it would go from *c* to *b*, back again to *c*—or twice as fast—if it were one quarter as long. After that, clocks were made short enough to stand on a shelf.

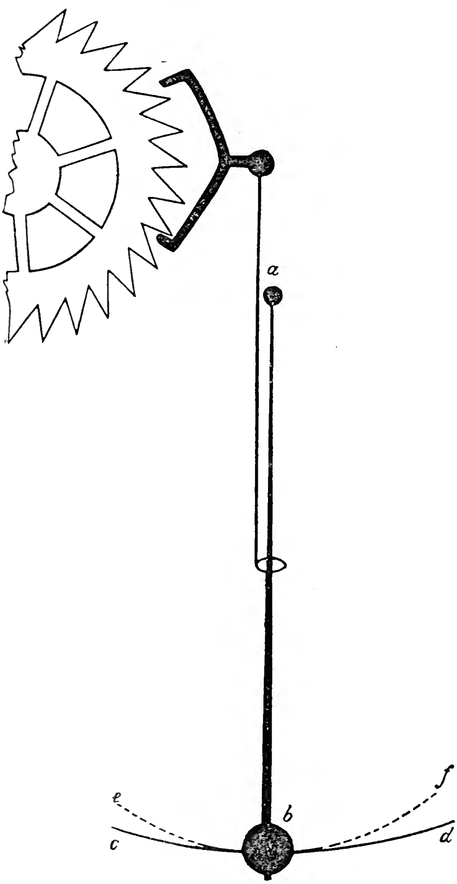


Fig. 2.

It had also been found that the bob of the pendulum, when moving in the arc of a circle, was not reliable; but that all the trouble was avoided if it moved in the arc of a cycloid (or "like a circle"). This arrangement is shown in Fig. 2. The pendulum hangs from a fixed point, *a*, where it is fastened securely. The upper end of the wire is beaten into a very thin spring. When the bob *b* moves back and forth, it does not move in the arc of the circle *c d*, but on the dotted

line *ef*. Great care is taken in preparing the spring at *a*, so that the bob will have no other motion than that from *e* to *f*. Should it move sidewise, or twist about, the clock will be spoiled. The bob was formerly flat, like a small plate, or round, like a ball. It was then a difficult matter to run the pendulum-wire through the exact center, and therefore the best bobs are now made in the form of a cylinder. A nut at the end of the wire keeps the bob from slipping off. If the nut is turned to the right, the pendulum is shortened, and the clock goes faster. If it is turned to the left, the clock goes slower. Sometimes it is necessary to regulate the pendulum without stopping it. This is done by placing small weights on the parts of it that project. In order to keep them of the same length, both in summer and in winter, pendulums were often made of wood; but it has been found that if the bob is made of bars of iron and zinc, or brass and steel, in the form of a gridiron, the different expansions of the two metals keep the pendulum at the right length. The pendulum-rod sometimes ends in a cup of mercury at the bob. When the heat expands the rod, the mercury is forced upward in the cup and nearer the fixed end of the pendulum. The object of both the gridiron pendulum and the mercurial is to bring the "center of oscillation" as near as possible to the "center of gravity." Another kind of a pendulum is called the "rotary," because the bob moves in a circle instead of going from side to side, but this is not thought to be at all reliable.

From what has been said already, you will see that the weight *h* (Fig. 1) would soon run away with the scape-wheel unless the pallets *d e f g* dodged in and out among the teeth and stopped it from going so fast. The pendulum, too, instead of moving back and forth between *b* and *c*, would stop half-way between them in a vertical or up-and-down line, like the plummets that the bricklayers use. A clock with simply the scape-wheel and the pendulum will soon run down; you must therefore have more wheels and a heavier weight to move them, or else your wheels will not move evenly enough to carry the minute- and hour-hands over the "face" that is outside. In Fig. 3 you will see that we have added other wheels; but you will recognize the scape-wheel in *c*, and the weight hanging to the wheel *a*. As it descends, the weight pulls the wheel *a* in the direction of the arrow. The wheel A turns with the wheel *a*, and it has seventy-eight "teeth," as the cogs are called. At *b* is a small wheel called a "pinion," with six "leaves," as the cogs are called. The large wheel, B, has also seventy-eight teeth; and the pinion *c* has also six leaves. While A is turning round once, B and *b* turn thirteen times, because *b* has one thirteenth as many teeth as A. In the same way C and *c* turn thirteen times as fast as B and *b*. I have a clock before me in which the wheel A turns once in one hundred and thirty minutes, or two hours and ten minutes. The wheel B turns in ten minutes, and the wheel C in ten thirteenths of a minute. You will see that the scape-wheel C does

not always take exactly a minute to go round. This scape-wheel has forty-two teeth, which is more than the usual number. If there were sixty teeth, and the pendulum marked one second at each swinging, the scape-wheel would turn once every minute. But this is not necessary; besides, the scape-wheel must be small enough for the pallets to take in about nine teeth between them, and yet be able to swing clear of them altogether.

The series of wheels in Fig. 3 is called the "train." You can not see the train in the clock so plainly as it is drawn in the picture, be-

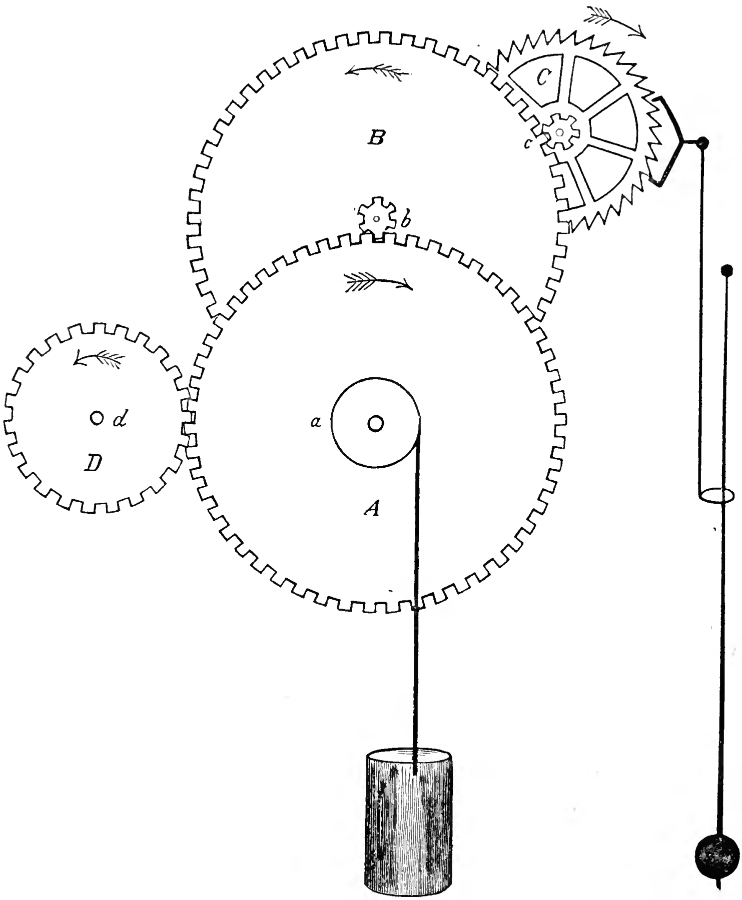


FIG. 3.

cause one wheel is placed behind the other in order to take as little room as possible. Sometimes, instead of only one wheel, B, between A and C, there will be two or three wheels—all of them smaller. The train of wheels is then harder to move, and the weight must be heavier. If the weight drops two inches in twenty-four hours, it will need a space

of sixteen inches if it is to run eight days. The length of time that the clock will run depends upon three things: 1. The length of the pendulum; 2. The space through which the weight falls; 3. The number of wheels in the train, and the number of teeth in each wheel. We have already seen how the length of the pendulum can be regulated. If the weight has a small space allowed for its fall, the clock may be made to run longer by increasing both the weight and the number of teeth. The number of teeth may be increased by increasing the number of wheels, or by putting in new wheels.

The wheel D, Fig. 3, is called the "center wheel," because it turns once in an hour. It has thirty-six teeth. In former times the wheel A turned once in twelve hours; and the axle, or "arbor," *a*, went through a hole in the face of the clock. A hand on the end of the arbor passed over certain figures on the face which marked the hours from one to twelve. This hand was called the hour-hand; but, as it could not mark the minutes, the center wheel, D, was so made that it would turn once in an hour, and thus, by carrying a hand over the face outside, marked the minutes. After this change was made no one cared whether the wheel A turned in one hour or in three hours, or whether the wheel C turned in one half minute or in two minutes, if only the wheel D turned in exactly one hour. At *d* is a "cannon" pinion that sticks to the arbor by friction. The minute-hand, which is placed upon the pinion, may thus be moved without turning the wheel D or any of the other wheels.

We must now provide an hour-hand. The cannon-pinion *a* (Fig. 4), with twelve leaves, runs on the arbor of the center wheel; but it could not be drawn in Fig. 3, because it is behind the center wheel, D. These twelve leaves, A (Fig. 4), run into thirty-six teeth in the wheel B. You will notice that the teeth and the leaves are not drawn in the picture. On the farther side of B is the pinion *b*, with twelve leaves which run into the forty-eight teeth of the wheel C. The wheel C and the pinion *b* are marked with dotted lines, because they are behind the pinion *a* and the wheel B. If *a* turns once in an hour, B will turn once in three hours, and C once in twelve hours. If what is called a "barrel" is placed over the cannon-pinion of the center wheel, and one end of it is fastened to the wheel C, the other end that comes through the face of the clock will carry the hour-hand. These wheels, in Fig. 4, are independent of the wheels in Fig. 3, except that *a*, in Fig. 4, fits upon the arbor *d*, of D, in Fig. 3 so loosely that you may turn the hour- and the minute-hand whenever you choose, and yet tightly enough to turn about with the wheel D if they are not dis-

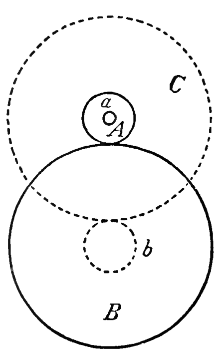


Fig. 4.

turbed. You can, therefore, move the two hands of the clock without disturbing any of the wheels in Fig. 3.

We have seen that the weight must keep pulling, or the clock will stop. Sometimes, instead of the weight, a spring is used, especially if the clock is small. The spring simply pushes the wheel A in the direction of the arrow (Fig. 3). When the spring is used the clock may have a pendulum escapement, or it may have a wheel escapement like that of a watch. But if the pressure of the spring is removed, or if the weight (should there be one) is lifted, the clock will stop. When you wind up the clock it is the same thing as taking away the weight, or the spring, while you are winding. How, then, can you wind it and still keep it going? This is done by what is called a "going-barrel," or "maintaining-works." In Fig. 3 you will notice that the wheel A turns in the direction of the arrow when the weight pulls down. When you wind up the clock the force of the weight is taken off. A strong spring is placed on the side of the wheel A that pushes it along in the direction of the arrow for the few seconds that you take in winding. Another wheel, or barrel, *a*, is placed on the large wheel A, and on this the string that holds the weight is wound. This wheel you turn in the opposite direction to that of the arrow. At the same time the spring pushes A in the direction of the arrow. You will sometimes see an old clock with an endless chain so arranged that, by pulling on a small weight, you may lift a large weight, and thus wind the clock. Others of the old time-pieces have weights that are hung by chains with rings at the upper end. When the weight has run down you can pull on the ring and the weight is lifted. You will find that all the best clocks, and all the watches, have the "maintaining-works."

The striking part of a clock is a very interesting study. It has a train of wheels and a weight entirely separate from the train that tells the hours and minutes by the hands. The large wheel, B, in Fig. 5, really consists of two wheels fastened together. The larger or outer wheel has seventy-eight teeth that run into a pinion, *a*, with thirteen leaves. The cord that holds the weight is wound on the axle of *a*, on which A is also fastened. There are thirteen pins on the surface of A. They can not be seen, because they are on the other side of the wheel; but they have been drawn in the picture so that the explanation may be more easily understood. As the wheel A turns, each pin strikes the end of the lever *c*, which, when it is released, springs back and strikes the bell *d*. The smaller wheel, B, has notches all about it—first, one notch; then two notches close together; then three notches close together; and so on until you find twelve notches all in one place. This makes seventy-eight notches in all. Behind the wheel B is a pinion that you can not see. It is turned by the wheel A, but it is entirely independent of B, although it turns on the same axis. This independent pinion turns a wheel almost as large as B, which

itself turns a small pinion that carries the "fly-fan." The use of the fan is to keep an even motion. The large wheel that we have spoken of turns once at every stroke of the bell. In Fig. 5, a wire, *e*, runs over to the center wheel, D. In Fig. 3, a pin on the center wheel pushes up this wire when the clock is ready to strike. If the end of the wire (in Fig. 5) rests at the four notches, it shows that four o'clock

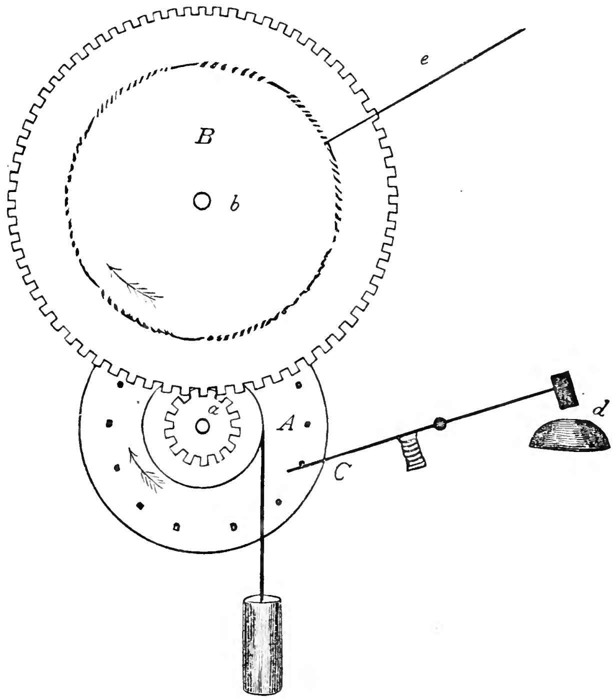


Fig. 5.

has been struck. If the center wheel pushes the wire up again, or pulls it out from the notch where it is resting, the large wheels at B are released; the weight commences to turn A and B, and the pins in A set the hammer *c* to striking the bell *d*. It keeps on striking until five has been struck. The wire then drops into a notch and holds the striking-wheel fast until the center wheel moves the wire again —thus saying that it is time to strike six. The wheels then turn again until the wire comes down and stops them. Alarm-clocks have an arrangement by which the spring that sounds the alarm is let loose at the hour when the owner wishes to be awakened.

The boys who went to school in New England sixty years ago had no such device to waken them in cold winter mornings as the modern alarm-clock; they had to waken each other, in order to have a good start in kindling their fires, so that they could enjoy an hour's hard study, and sometimes a recitation, before breakfast.

But it was not always convenient for one to keep awake in order to waken his companions. The one who was on guard was as sleepy as any of the rest: so the inventive brains of the Yankee boys were set to work to find some way of giving an alarm at the right time. Let it be remembered that, while primitive alarm-clocks were to be had in Europe, and while "repeating"-watches were a luxury in America, neither of them were to be found in New England as it was then. Even if the repeating-watch had been in general use, it was valueless, except to tell the time in the dark when one was awake. The invention of the alarm-clock was, therefore, a greater advance in the history of clock-making than was the invention of time-locks in the history of lock-making. The essential feature of the time-lock is a chronometer that turns a wheel containing a pin so adjusted that it will reach a certain point in a fixed time. Then a "dog" drops down, removes the obstruction, and allows the bolt to be shoved back. Two chronometers are used, so that, in case one runs down, the other will do the work. They are hung on springs, for fear that they will run down if the burglars should use dynamite, or some other explosive, to give them a sudden jar.

The Yankee boys, at the time that I have spoken of, were equal to the difficulty of awakening at the exact time. They invented a contrivance which was an indication of what was coming in both the alarm-clock and the time-lock. Indeed, it was so nearly a combination of the two that we must take away from the more modern inventors some of the credit and bestow it upon the boys.

In order to explain the plan more clearly, I ought first to say that the watches worn by both the men and the boys were of the large and coarse pattern known as "bull's-eyes"—a name given because the crystals were very thick, and bulged out something like the lens of a dark-lantern. The watches of this kind were not only very thick, but they were very large in diameter. The springs were very strong, and the hands were very stout. Therefore, the power that moved the hands was much greater than the power that moves the hands in the watches that are made to-day.

The boys prepared a board, *a b c d*, Fig. 6, about a foot square. Toward the upper edge, at *e*, they scooped out a place large enough for the watch to drop into, and have the face even, or flush, with the surface of the board. The face of the watch was then fastened to the board. The crystal was opened, or taken away entirely, and thus the hands traveled around just as if they had been on the board itself. A small wooden lever, *j g*, was fastened to the board by a nail, *f*, that acted as a fulcrum. Another lever, *g i*, had a fulcrum at *h*, and touched the first lever at *g*. The board was kept at a slant on the table by the prop *n*, or else by a pile of books behind it. The lever *g j* was so adjusted that the minute-hand of the watch would pass over the end, *j*; but when the given hour-hand, *v*, for instance, came

round, it would strike *j* to the left. The effect would be this : *g* would move to the right and *i* to the left, thus pushing the weight at *i* from the little shelf on which it was balanced, and causing it to tumble toward the floor.

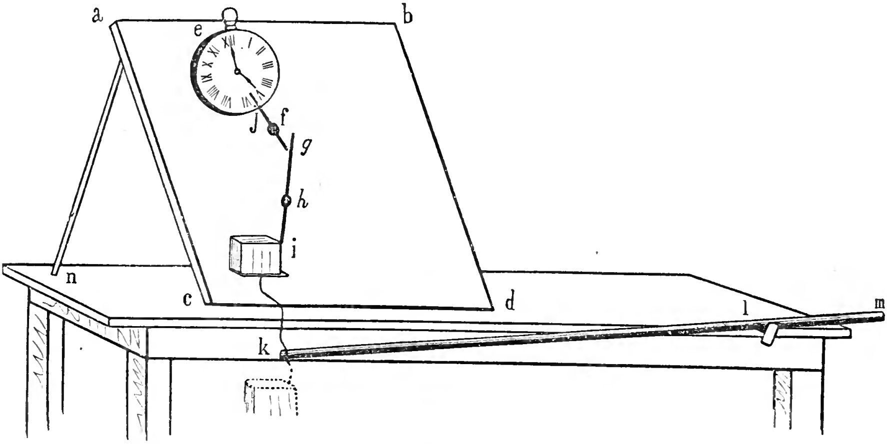


Fig. 6.

You can imagine that the force set in motion by the hour-hand of the watch, even of a "bull's-eye," was not enough to start a very heavy weight. Therefore, the dropping of the weight at *i* was not enough of a noise to awaken the boys, but the force that was exerted was enough, applied at the end of a long lever, to transfer itself to a point where it would do more good. The weight *i*, in dropping, pulled a string that was fastened on the long arm of the lever *k m*. This lever was fastened to the edge of the same table that held the square board by a gimlet, or nail, as a fulcrum, at *l*. When *i* dropped, it pulled *k* down and pushed *m* up. The sudden jerk at *m* pushed over a nicely balanced table, upon which had been placed nearly all the chairs and other furniture in the room. This certainly made enough noise to awaken the occupants of the room, and it is not likely there was much sleep after that. It was a great deal of trouble to adjust so nicely all the different parts of this primitive alarm-clock ; but it never failed to work when care was taken with all the details. Let us praise the boys for studying out a scheme which others have adopted and called their own. They preferred to lie in bed as long as possible, and did not propose to keep awake all night, if any machinery could be devised to do the awaking for them.

A few words in regard to the dial on the face of the clock. The dial of a clock, if it is a cheap one, is made of wood and painted white. If the dial is small and expensive, it is made of copper on which is baked a white enamel surface. The figures are marked in black paint, which is sometimes burned or "baked in." The usual size of the fig-

ures from I to XII is one third of the distance from the outer circle toward the center. If the face of the clock is white, the figures and the hands should be black. If the face is black, or any dark color, the figures and hands should be either white or gilt. The dials of tower-clocks are frequently illuminated by gas or electricity, so that the time may be easily determined at night.

THE FACTORS OF ORGANIC EVOLUTION.

By HERBERT SPENCER.

III.

LIMITED, as thus far drawn, to a certain common trait of those minute organisms which are mostly below the reach of unaided vision, the foregoing conclusion appears trivial enough. But it ceases to appear trivial on passing beyond these limits, and observing the implications, direct and indirect, as they concern plants and animals of sensible sizes.

Popular expositions of science have so far familiarized many readers with a certain fundamental trait of living things around, that they have ceased to perceive how marvellous a trait it is, and until interpreted by the Theory of Evolution, how utterly mysterious. In past times, the conception of an ordinary plant or animal which prevailed, not throughout the world at large only but among the most instructed, was that it is a single continuous entity. One of these living things was unhesitatingly regarded as being in all respects a unit. Parts it might have, various in their sizes, forms, and compositions; but these were components of a whole which had been from the beginning in its original nature a whole. Even to naturalists fifty years ago, the assertion that a cabbage or a cow, though in one sense a whole, is in another sense a vast society of minute individuals, severally living in greater or less degrees, and some of them maintaining their independent lives unrestrained, would have seemed an absurdity. But this truth which, like so many of the truths established by science, is contrary to that common sense in which most people have so much confidence, has been gradually growing clear since the days when Leeuwenhoeck and his contemporaries began to examine through lenses the minute structures of common plants and animals. Each improvement in the microscope, while it has widened our knowledge of those minute forms of life described above, has revealed further evidence of the fact that all the larger forms of life consist of units severally allied in their fundamental traits to these minute forms of life. Though, as formulated by Schwann and Schleiden, the cell-doctrine has undergone qualifications of statement; yet the qualifications have not been such as to militate against the general proposition that organisms visible to the

naked eye, are severally compounded of invisible organisms—using that word in its most comprehensive sense. And then, when the development of any animal is traced, it is found that having been primarily a nucleated cell, and having afterwards become by spontaneous fission a cluster of nucleated cells, it goes on through successive stages to form out of such cells, ever multiplying and modifying in various ways, the several tissues and organs composing the adult.

On the hypothesis of evolution this universal trait has to be accepted not as a fact that is strange but unmeaning. It has to be accepted as evidence that all the visible forms of life have arisen by union of the invisible forms; which, instead of flying apart, when they divided, remained together. Various intermediate stages are known. Among plants, those of the *Volvox* type show us the component protophytes so feebly combined that they severally carry on their lives with no appreciable subordination to the life of the group. And among animals, a parallel relation between the lives of the units and the life of the group is shown us in *Uroglena* and *Syncrypta*. From these first stages upwards, may be traced through successively higher types, an increasing subordination of the units to the aggregate; though still a subordination leaving to them conspicuous amounts of individual activity. Joining which facts with the phenomena presented by the cell-multiplication and aggregation of every unfolding germ, naturalists are now accepting the conclusion that by this process of composition from *Protozoa* were formed all classes of the *Metazoa* *—(as animals formed by this compounding are now called); and that in a similar way from *Protophyta*, were formed all classes of what, by analogy, I suppose will be called *Metaphyta*, though the word does not yet seem to have become current.

And now what is the general meaning of these truths, taken in connexion with the conclusion reached in the last section? It is that this universal trait of the *Metazoa* and *Metaphyta*, must be ascribed to the primitive action and re-action between the organism and its medium. The operation of those forces which produced the primary differentiation of outer from inner in early minute masses of protoplasm, pre-determined this universal cell-structure of all embryos, plant and animal, and the consequent cell-composition of adult forms arising from them. How unavoidable is this implication, will be seen on carrying further an illustration already used—that of the shingle-covered shore, the pebbles on which, while being in some cases selected, have been in all cases rounded and smoothed. Suppose a bed of such shingle to be, as we often see it, solidified, along with interfused material, into a conglomerate. What in such case must be considered as the chief trait of such conglomerate; or rather—what must we regard as the chief cause of its distinctive characters? Evidently the action of the sea. Without the breakers, no pebbles; without the

* *A Treatise on Comparative Embryology.* By F. M. Balfour. Vol. II, chap. xiii.

pebbles, no conglomerate. Similarly then, in the absence of that action of the medium by which was effected the differentiation of outer from inner in those microscopic portions of protoplasm constituting the earliest and simplest animals and plants, there could not have existed this cardinal trait of composition which all the higher animals and plants show us.

So that, active as has been the part played by natural selection, alike in modifying and moulding the original units—largely as survival of the fittest has been instrumental in furthering and controlling the aggregation of these units into visible organisms and eventually into large ones; yet we must ascribe to the direct effect of the medium on primitive forms of life, that primordial trait of which this everywhere-operative factor has taken advantage.

Let us turn now to another and more manifest trait of higher organisms, for which also there is this same general cause. Let us observe how, on a higher platform, there recurs this differentiation of outer from inner—how this primary trait in the living units with which life commences, re-appears as a primary trait in those aggregates of such units which constitute visible organisms.

In its simplest and most unmistakable form, we see this in the early changes of an unfolding ovum of primitive type. The original fertilized single cell, having by spontaneous fusion multiplied into a cluster of such cells, there begins to show itself a contrast between periphery and centre; and presently there is formed a sphere consisting of a superficial layer unlike its contents. The first change, then, is the rise of a difference between that outer part which holds direct converse with the surrounding medium, and that inclosed part which does not. This primary differentiation in these compound embryos of higher animals, parallels the primary differentiation undergone by the simplest living things.

Leaving, for the present, succeeding changes of the compound embryo, the significance of which we shall have to consider by-and-by, let us pass now to the adult forms of visible plants and animals. In them we find cardinal traits which, after what we have seen above, will further impress us with the importance of the effects wrought on the organism by its medium.

From the thallus of a sea-weed up to the leaf of a highly developed phænogam, we find, at all stages, a contrast between the inner and outer parts of these flattened masses of tissue. In the higher *Algæ* "the outermost layers consist of smaller and firmer cells, while the inner cells are often very large, and sometimes extremely long;" * and in the leaves of trees the epidermal layer, besides differing in the sizes and shapes of its component cells from the parenchyma forming the inner substance of the leaf, is itself differentiated by having a con-

* Sachs, p. 210.

tinuous cuticle, and by having the outer walls of its cells unlike the inner walls.* Especially instructive is the structure of such intermediate types as the Liverworts. Beyond the differentiation of the covering cells from the contained cells, and the contrast between upper surface and under surface, the frond of *Marchantia polymorpha* clearly shows us the direct effect of incident forces: and shows us, too, how it is involved with the effect of inherited proclivities. The frond grows from a flat disc-shaped gemma, the two sides of which are alike. Either side may fall uppermost; and then of the developing shoot, the side exposed to the light "is under all circumstances the upper side which forms stomata, the dark side becomes the under side which produces root-hairs and leafy processes." † So that while we have undeniable proof that the contrasted influences of the medium on the two sides, initiate the differentiation, we have also proof that the completion of it is determined by the transmitted structure of the type; since it is impossible to ascribe the development of stomata to the direct action of air and light. On turning from foliar expansion to stems and roots, facts of like meaning meet us. Speaking generally of epidermal tissue and inner tissue, Sachs remarks that "the contrast of the two is the plainer the more the part of the plant concerned is exposed to air and light." ‡ Elsewhere, in correspondence with this, it is said that in roots the cells of the epidermis, though distinguished by bearing hairs, "are otherwise similar to those of the fundamental tissue" # which they clothe, while the cuticular covering is relatively thin; whereas in stems the epidermis (often further differentiated) is composed of layers of cells which are smaller and thicker-walled: a stronger contrast of structure corresponding to a stronger contrast of conditions. By way of meeting the suggestion that these respective differences are wholly due to the natural selection of favourable variations, it will suffice if I draw attention to the unlikeness between imbedded roots and exposed roots. While in darkness, and surrounded by moist earth, the outermost protective coats, even of large roots, are comparatively thin; but when the accidents of growth entail permanent exposure to light and air, roots acquire coverings allied in character to the coverings of branches. That the action of the medium causes these and converse changes, cannot be doubted when we find, on the one hand, that "roots can become directly transformed into leaf-bearing shoots," and, on the other hand, that in some plants certain "apparent roots are only underground shoots," and that nevertheless "they are similar to true roots in function and in the formation of tissue, but have no root-cap, and, when they come to the light above ground, continue to grow in the manner of ordinary leaf-shoots." ‖ If, then, in highly developed plants inheriting pronounced structures, this differentiating

* Sachs, pp. 83–4. † *Ibid.*, p. 185. ‡ *Ibid.*, p. 8. # *Ibid.*, p. 83.
‖ *Ibid.*, p. 147.

influence of the medium is so marked, it must have been all-important at the outset while types were undetermined.

As with plants so with animals, we find good reason for inferring that while all the specialities of the tegumentary parts must be ascribed to the natural selection of favourable variations, their most general traits are due to the direct action of surrounding agencies. Here we come upon the border of those changes which are ascribable to use and disuse. But from this class of changes we may fitly exclude those in which the parts concerned are wholly or mainly passive. A corn and a blister will conveniently serve to illustrate the way in which certain outer actions produce in the superficial tissues, effects of a purely physical kind—effects related neither to the needs of the organism nor to its structural proclivities. They are neither adaptive changes nor changes towards completion of the type. After noting them we may pass to allied, but still more instructive, facts. Continuous pressure on any portion of the surface causes absorption, while intermittent pressure causes growth : the one impeding circulation and the passage of plasma from the capillaries into the tissues, and the other aiding both. There are further mechanically-produced effects. That the general character of the ribbed skin on the under surfaces of the feet and insides of the hands is directly due to friction and intermittent pressure, we have the proofs :—first, that the tracts most exposed to rough usage are the most ribbed ; second, that the insides of hands subject to unusual amounts of rough usage, as those of sailors, are strongly ribbed all over ; and third, that in hands which are very little used, the parts commonly ribbed become quite smooth. These several kinds of evidence, however, full of meaning as they are, I give simply to prepare the way for evidence of a much more conclusive kind.

Where ulceration has eaten away the deep-seated layer out of which the epidermis grows, or where this layer has been destroyed by an extensive burn, the process of healing is very significant. From the subjacent tissues, which in the normal order have no concern with outward growth, there is produced a new skin, or rather a pro-skin ; for this substituted outward-growing layer contains no hair-follicles or other specialities of the original one. Nevertheless, it is like the original one in so far that it is a continually renewed protective covering. Doubtless it may be contended that this make-shift skin results from the inherited proclivity of the type—the tendency to complete afresh the structure of the species when injured. We cannot, however, ignore the immediate influence of the medium, on recalling the facts above named, or on remembering the further fact that an inflamed surface of skin, when not sheltered from the air, will throw out a film of coagulable lymph. But that the direct action of the medium is a chief factor we are clearly shown by another case. Accident or disease occasionally causes permanent eversion, or protrusion, of mucous membrane. After

a period of irritability, great at first but decreasing as the change advances, this membrane assumes the general character of ordinary skin. Nor is this all: its microscopic structure changes. Where it is a mucous membrane of the kind covered by cylinder-epithelium, the cylinders gradually shorten, becoming finally flat, and there results a squamous epithelium: there is a near approach in minute composition to epidermis. Here a tendency towards completion of the type cannot be alleged; for there is, contrariwise, divergence from the type. The effect of the medium is so great that, in a short time, it overcomes the inherited proclivity and produces a structure of opposite kind to the normal one.

Fully to perceive the way in which these evidences compel us to recognize the influence of the medium as a primordial factor, we need but conceive them as interpreted without it. Suppose, for instance, we say that the structure of the epidermis is wholly determined by the natural selection of favourable variations; what must be the position taken in presence of the fact above named, that the cell-structure of mucous membrane changes into the cell-structure of skin when mucous membrane is exposed to the air? The position taken must be this:—Though mucous membrane in a highly-evolved individual organism, thus shows the powerful effect of the medium on its surface; yet we must not suppose that the medium had the effect of producing such a cell-structure on the surfaces of primitive forms, undifferentiated though they were; or, if we suppose that such an effect was produced on them, we must not suppose that it was inheritable. Contrariwise, we must suppose that such effects of the medium either were not wrought at all, or that they were evanescent: though repeated through millions upon millions of generations they left no traces. And we must conclude that this skin-structure arose only in consequence of spontaneous variations not physically initiated (though like those physically initiated) which natural selection laid hold of and increased. Does any one think this a tenable position?

And now we approach the last and chief series of morphological phenomena which must be ascribed to the direct action of environing matters and forces. These are presented to us when we study the early stages in the development of the embryos of the *Metazoa* in general.

We will set out with the fact already noted in passing, that after repeated spontaneous fissions have changed the original fertilized germ-cell into that cluster of cells which forms a gemmule or a primitive ovum, the first contrast which arises is between the peripheral parts and the central parts. Where, as with lower creatures which do not lay up large stores of nutriment with the germs of their offspring, the inner mass is inconsiderable, the outer layer of cells, which are presently made quite small by repeated subdivisions, forms a membrane

extending over the whole surface—the blastoderm. The next stage of development, which ends in this covering layer becoming double, is reached in two ways—by invagination and by delamination; but which is the original way, and which the abridged way, is not quite certain. Of invagination, multitudinously exemplified in the lowest types, Mr. Balfour says:—"On purely *à priori* grounds there is in my opinion more to be said for invagination than for any other view"; * and, for present purposes, it will suffice if we limit ourselves to this: making its nature clear to the general reader by a simple illustration.

Take a small india-rubber ball—not of the inflated kind, nor of the solid kind, but of the kind about an inch or so in diameter with a small hole through which, under pressure, the air escapes. Suppose that instead of consisting of india-rubber its wall consists of small cells made polyhedral in form by mutual pressure, and united together. This will represent the blastoderm. Now with the finger, thrust in one side of the ball until it touches the other: so making a cup. This action will stand for the process of invagination. Imagine that by continuance of it, the hemispherical cup becomes very much deepened and the opening narrowed, until the cup becomes a sac, of which the introverted wall is everywhere in contact with the outer wall. This will represent the two-layered "gastrula"—the simplest ancestral form of the *Metazoa:* a form which is permanently represented in some of the lowest types; for it needs but tentacles round the mouth of the sac, to produce a common hydra. Here the fact which it chiefly concerns us to remark, is that of these two layers the outer, called in embryological language the epiblast, continues to carry on direct converse with the forces and matters in the environment; while the inner, called the hypoblast, comes in contact with such only of these matters as are put into the food-cavity which it lines. We have further to note that in the embryos of *Metazoa* at all advanced in organization, there arises between these two layers a third—the mesoblast. The origin of this is seen in types where the developmental process is not obscured by the presence of a large food-yolk. While the above-described introversion is taking place, and before the inner surfaces of the resulting epiblast and hypoblast have come into contact, cells, or amœboid units equivalent to them, are budded off from one or both of these inner surfaces, or some part of one or other; and these form a layer which eventually lies between the other two—a layer which, as this mode of formation implies, never has any converse with the surrounding medium and its contents, or with the nutritive bodies taken in from it. The striking facts to which this description is a necessary introduction, may now be stated. From the outer layer, or epiblast, are developed the permanent skin and its outgrowths, the nervous system, and the organs of sense; from the intro-

* *A Treatise on Comparative Embryology.* By Francis M. Balfour, LL. D., F. R. S. Vol. II, p. 343 (second edition).

verted layer, or hypoblast, are developed the alimentary canal along with those parts of its appended organs, liver, pancreas, &c., which are concerned in delivering their secretions into the alimentary canal, as well as the linings of those ramifying tubes in the lungs which convey air to the places where gaseous exchange is effected. And from the mesoblast originate the bones, the muscles, the heart and blood-vessels, and the lymphatics, together with such parts of various internal organs as are most remotely concerned with the outer world. Minor qualifications being admitted, there remain the broad general facts, that out of that part of the external layer which remains permanently external, are developed all the structures which carry on intercourse with the medium and its contents, active and passive; out of the introverted part of this external layer, are developed the structures which carry on intercourse with the quasi-external substances that are taken into the interior—solid food, water, and air; while out of the mesoblast are developed structures which have never had, from first to last, any intercourse with the environment. Let us contemplate these general facts.

Who would have imagined that the nervous system is a modified portion of the primitive epidermis? In the absence of proofs furnished by the concurrent testimony of embryologists during the last thirty or forty years, who would have believed that the brain arises from an infolded tract of the outer skin, which, sinking down beneath the surface, becomes imbedded in other tissues and eventually surrounded by a bony case? Yet the human nervous system in common with the nervous systems of lower animals is thus originated. In the words of Mr. Balfour, early embryological changes imply that—

> "the functions of the central nervous system, which were originally taken by the whole skin, became gradually concentrated in a special part of the skin which was step by step removed from the surface, and has finally become in the higher types a well-defined organ imbedded in the subdermal tissues. . . . The embryological evidence shows that the ganglion-cells of the central part of the nervous system are originally derived from the simple undifferentiated epithelial cells of the surface of the body." *

Less startling perhaps, though still startling enough, is the fact that the eye is evolved out of a portion of the skin; and that while the crystalline lens and its surroundings thus originate, the "percipient portions of the organs of special sense, especially of optic organs, are often formed from the same part of the primitive epidermis" which forms the central nervous system.† Similarly is it with the organs for smelling and hearing. These, too, begin as sacs formed by infoldings of the epidermis; and while their parts are developing they are joined from within by nervous structures which were themselves epidermic in origin. How are we to interpret these strange transformations? Observing, as we pass, how absurd from the point of view of

* Balfour, l.c. Vol. ii, p. 400–1. † *Ibid.*, p. 401.

the special-creationist, would appear such a filiation of structures, and such a round-about mode of embryonic development, we have here to remark that the process is not one to have been anticipated as a result of natural selection. After numbers of spontaneous variations had occurred, as the hypothesis implies, in useless ways, the variation which primarily initiated a nervous centre might reasonably have been expected to occur in some internal part where it would be fitly located: its initiation in a dangerous place and subsequent migration to a safe place, would be incomprehensible. Not so if we bear in mind the cardinal truth above set forth, that the structures for holding converse with the medium and its contents, arise in that completely superficial part which is directly affected by the medium and its contents; and if we draw the inference that the external actions themselves initiate the structures. These once commenced, and furthered by natural selection where favourable to life, would form the first term of a series ending in developed sense organs and a developed nervous system.*

Though it would enforce the argument, I must, for brevity's sake, pass over the analogous evolution of that introverted layer, or hypoblast, out of which the alimentary canal and attached organs arise. It will suffice to emphasize the fact that having been originally external, this layer continues in its developed form to have a quasi-externality, alike in its digesting part and in its respiratory part; since it continues to deal with matters alien to the organism. I must also refrain from dwelling at length on the fact already adverted to, that the intermediate derived layer, or mesoblast, which was at the outset completely internal, originates those structures which ever remain completely internal, and have no communication with the environment save through the structures developed from the other two: an antithesis which has great significance.

Here, instead of dwelling on these details, it will be better to draw attention to the most general aspect of the facts. Whatever may be the course of subsequent changes, the first change is the formation of a superficial layer or blastoderm; and by whatever series of transformations the adult structure is reached, it is from the blastoderm that all the organs forming the adult originate. Why this marvellous fact? Why out of the primitive mass of organizable substance which is to form a new creature, should its surface be the part from which is remotely derived its entire structure? Before embryologists had established this truth, anyone who had asserted it would have been thought insane; and even now it remains a mystery if we refuse to take account of the direct relations between the organism and the medium. But we need only consider the incidents of this relation to get a feasible explanation. Before yet the primitive *metazoon* had any structure beyond that possessed by its component cells, its outer sur-

* For a general delineation of the changes by which the development is effected, see Balfour, l.c. Vol. ii, pp. 401–4.

face was the part through which nutritive matters were taken in and through which were absorbed and exhaled, oxygen and carbonic acid. Its outer surface was the part which now touched quiescent masses, and now received the collisions consequent on its own motions or the motions of others similarly carried along by their cilia. Its outer surface was the part to receive the sound-vibrations occasionally propagated through the water; the part to be affected more strongly than any other by those variations in the amounts of light caused by the passing of small bodies close to it; and the part which met those diffused molecules constituting odours. That is to say, at the outset the surface was the part on which there fell the various influences pervading the environment, through which there passed the materials for growth furnished by the environment, by which there were received those impressions from the environment serving for the guidance of actions, and which had to bear the mechanical re-actions consequent upon such actions. Necessarily, therefore, the surface was the part in which were initiated the various instrumentalities for carrying on intercourse with the environment. To suppose otherwise is to suppose that such instrumentalities arose internally where they could neither be operated on by surrounding agencies nor operate on them,—where the differentiating forces did not come into play, and the differentiated structures had nothing to do; and it is to suppose that meanwhile the parts directly exposed to the differentiating forces remained unchanged. Clearly, then, organization could not but begin on the surface; and having thus begun, its subsequent course could not but be determined by its superficial origin. And hence these remarkable facts showing us that individual evolution is accomplished by successive in-foldings and in-growings. Doubtless natural selection soon came into action, as, for example, in the removal of the rudimentary nervous centres from the surface; since an individual in which they were a little more deeply seated would be less likely to be incapacitated by injury of them. And so in multitudinous other ways. But nevertheless, as we here see, natural selection could operate only under subjection: it could do no more than take advantage of those structural changes which the medium and its contents initiated.

See, then, how large has been the part played by this primordial factor. Had it done no more than give to *Protozoa* and *Protophyta* that cell-form which characterizes them—had it done no more than entail the cellular composition which is so remarkable a trait of *Metazoa* and *Metaphyta*—had it done no more than cause the repetition in all visible animals and plants of that primary differentiation of outer from inner which it first wrought in animals and plants invisible to the naked eye; it would have done much towards giving to organisms of all kinds certain leading traits. But it has done more than this. By causing the first differentiations of those clusters of units out of which visible animals in general arose, it fixed the starting place

for organization, and therefore determined the course of organization; and, doing this, gave indelible traits to embryonic transformations and to adult structures.

Though mainly carried on after the inductive method, the argument at the close of the foregoing section has verged towards the deductive. Here let us follow for a space the deductive method pure and simple. Doubtless in biology *à priori* reasoning is dangerous; but there can be no danger in considering whether its results coincide with those reached by reasoning *à posteriori*.

Biologists in general agree that in the present state of the world, no such thing happens as the rise of a living creature out of non-living matter. They do not deny, however, that at a remote period in the past, when the temperature of the Earth's surface was much higher than at present, and other physical conditions were unlike those we know, inorganic matter, through successive complications, gave origin to organic matter. So many substances once supposed to belong exclusively to living bodies, have now been formed artificially, that men of science scarcely question the conclusion that there are conditions under which, by yet another step of composition, quaternary compounds of lower types pass into those of highest types. That there once took place gradual divergence of the organic from the inorganic, is, indeed, a necessary implication of the hypothesis of Evolution, taken as a whole; and if we accept it as a whole, we must put to ourselves the question—What were the early stages of progress which followed, after the most complex form of matter had arisen out of forms of matter a degree less complex?

At first, protoplasm could have had no proclivities to one or other arrangement of parts; unless, indeed, a purely mechanical proclivity towards a spherical form when suspended in a liquid. At the outset it must have been passive. In respect of its passivity, primitive organic matter must have been like inorganic matter. No such thing as spontaneous variation could have occurred in it; for variation implies some habitual course of change from which it is a divergence, and is therefore excluded where there is no habitual course of change. In the absence of that cyclical series of metamorphoses which even the simplest living thing now shows us, as a result of its inherited constitution, there could be no *point d'appui* for natural selection. How, then, did organic evolution begin?

If a primitive mass of organic matter was like a mass of inorganic matter in respect of its passivity, and differed only in respect of its greater changeableness; then we must infer that its first changes conformed to the same general law as do the changes of an inorganic mass. The instability of the homogeneous is a universal principle. In all cases the homogeneous tends to pass into the heterogeneous, and the less heterogeneous into the more heterogeneous. In the primor-

dial units of protoplasm, then, the step with which evolution commenced must have been the passage from a state of complete likeness throughout the mass to a state in which there existed some unlikeness. Further, the cause of this step in one of these portions of organic matter, as in any portion of inorganic matter, must have been the different exposure of its parts to incident forces. What incident forces? Those of its medium or environment. Which were the parts thus differently exposed? Necessarily the outside and the inside. Inevitably, then, alike in the organic aggregate and the inorganic aggregate (supposing it to have coherence enough to maintain constant relative positions among its parts), the first fall from homogeneity to heterogeneity must always have been the differentiation of the external surface from the internal contents. No matter whether the modification was physical or chemical, one of composition or of decomposition, it comes within the same generalization. The direct action of the medium was the primordial factor of organic evolution.

In his article on Evolution in the *Encyclopædia Britannica*, Professor Huxley writes as follows :—

> "How far 'natural selection' suffices for the production of species remains to be seen. Few can doubt that, if not the whole cause, it is a very important factor in that operation. . . .
> On the evidence of palæontology, the evolution of many existing forms of animal life from their predecessors is no longer an hypothesis, but an historical fact; it is only the nature of the physiological factors to which that evolution is due which is still open to discussion."

With these passages I may fitly join a remark made in the admirable address Prof. Huxley delivered before unveiling the statue of Mr. Darwin in the Museum at South Kensington. Deprecating the supposition that an authoritative sanction was given by the ceremony to the current ideas concerning organic evolution, he said that "science commits suicide when it adopts a creed."

Along with larger motives, one motive which has joined in prompting the foregoing articles, has been the desire to point out that already among biologists, the beliefs concerning the origin of species have assumed too much the character of a creed ; and that while becoming settled they have been narrowed. So far from further broadening that broader view which Mr. Darwin reached as he grew older, his followers appear to have retrograded towards a more restricted view than he ever expressed. Thus there seems occasion for recognizing the warning uttered by Prof. Huxley, as not uncalled for.

Whatever may be thought of the foregoing arguments and conclusions, they will perhaps serve to show that it is as yet far too soon to close the inquiry concerning the causes of organic evolution.

ETHNOLOGY OF THE BLACKFOOT TRIBES.

By HORATIO HALE.

THE tribes composing the Blackfoot Confederacy, as it is commonly styled, are in some respects the most important and interesting Indian communities of the Northwest; but they have been until recently less known than any others in that region. A report on these tribes having been requested by the British Association for the Advancement of Science, a correspondence was opened by the writer with two able and zealous missionaries residing among those Indians. These were the Rev. Albert Lacombe, widely and favorably known as Father Lacombe, author of a valuable grammar and dictionary of the Cree language, and now missionary among the Siksika, or proper Blackfoot Indians; and the Rev. John McLean, missionary of the Canadian Methodist Church to the Blood and Piegan tribes, who is now preparing a translation of the Scriptures into the Blackfoot tongue. To these gentlemen, who responded most courteously and liberally to the inquiries made of them, the report (of which the following is mainly a summary) is indebted for most of the facts which it contains. For the conclusions drawn from these facts the writer only is responsible. Some other sources have been consulted, particularly the valuable official reports of the Canadian and United States Indian Departments. Something has also been drawn from the writer's own notes, made formerly during an exploring tour in Oregon.

Fifty years ago the Blackfoot Confederacy held among the Western tribes much the same position of superiority which was held two centuries ago by the Iroquois Confederacy (then known as the Five Nations) among the Indians east of the Mississippi. The tribes of the former confederacy were also, when first known, five in number. The nucleus, or main body, was—as it still is—composed of three tribes speaking the proper Blackfoot language. These are the *Siksika*, or Blackfeet proper, the *Kena*, or Blood Indians, and the *Piekané*, or Piegans (pronounced Peegans)—a name sometimes corrupted to Pagan Indians. Two other tribes joined this original confederacy, or, perhaps, more accurately speaking, came under its protection. These were the Sarcees from the north and the Atsinas from the south. The Sarcees are an offshoot of the great Athabascan stock, which is spread over the north of British America, in contact with the Esquimaux, and extends, in scattered bands—the Umpquas, Apaches, and others—through Oregon and California, into Northern Mexico. The Atsinas, who have been variously known, from the reports of Indian traders, as Fall Indians, Rapid Indians, and Gros Ventres, speak a dialect similar to that of the Arapahoes, who now reside in the "Indian Territory" of the United States. It is a peculiarly harsh and difficult lan-

guage, and is said to be spoken only by those two tribes. None of the Atsinas are now found on Canadian territory, and no recent information has been obtained concerning them except from the map which accompanies the United States Indian Report for 1884, in which their name appears on the American Blackfoot Reservation.

The five tribes were reckoned, fifty years ago, to comprise not less than thirty thousand souls. Their numbers, union, and warlike spirit, made them the terror of all the Western Indians. It was not uncommon for thirty or forty war-parties to be out at once against the hostile tribes of Oregon and of the eastern plains, from the Shoshonees of the south to the Crees of the far north. The country which the Blackfoot tribes claimed properly as their own comprised the valleys and plains along the eastern slope of the Rocky Mountains, from the Missouri to the Saskatchewan. This region was the favorite resort of the buffalo, whose vast herds afforded the Indians their principal means of subsistence. In the year 1836 a terrible visitation of the small-pox swept off two thirds of the people ; and five years later they were supposed to count not more than fifteen hundred tents, or about ten thousand souls. Their enemies were then recovering their spirits and retaliating upon the weakened tribes the ravages which they had formerly committed.

In 1855 the United States Government humanely interfered to bring about a complete cessation of hostilities between the Blackfoot tribes and the other Indians. The commissioners appointed for the purpose summoned the hostile tribes together and framed a treaty for them, accompanying the act with a liberal distribution of presents to bring the tribes into good-humor. This judicious proceeding proved effectual. Dr. F. V. Hayden, in his account of the Indian tribes of the Missouri Valley, states that from the period of the treaty the Blackfoot tribes had become more and more peaceful in their habits, and were considered, when he wrote, the best disposed Indians in the Northwest. He remarks that their earlier reputation for ferocity was doubtless derived from their enemies, who always gave them ample cause for attacking them. "In an intellectual and moral point of view," he adds, "they take the highest rank among the wild tribes of the West." The recent reports of the Indian agents and other officials of the Canadian Northwest confirm this favorable opinion of the superior honesty and intelligence of the Blackfoot tribes. While constantly harassed on their reserves by the incursions of thievish Crees and other Indians, who rob them of their horses, they forbear to retaliate, and honorably abide by the terms of their late treaty, which binds them to leave the redress of such grievances to the Canadian authorities.

Since the general peace was established by the American Government, the numbers of the Blackfeet have apparently been on the increase. Dr. Hayden reports the three proper Blackfoot tribes as num-

bering, in 1855, about seven thousand souls. The present population of the three Canadian reserves is computed at about six thousand, divided as follows: Blackfeet proper (Siksika), twenty-four hundred; Bloods, twenty-eight hundred; Piegans, eight hundred. On the American reservation there are said to be about twenty-three hundred, mostly Piegans. This would make the total population of the three tribes exceed eight thousand souls. The adopted tribe, the Sarcees, have greatly diminished in numbers through the ravages of the small-pox. There are now less than five hundred, who reside on a small reserve of their own, near the town of Calgary.

During the past five years, as is well known, a great change has taken place in the condition of all the Western tribes through the complete extermination of the buffalo. The Blackfeet have been the greatest sufferers from this cause. The herds were not only their main dependence for food, but also furnished the skins which made their tents and their clothing. Suddenly, almost without warning, they found themselves stripped of nearly every necessary of life. The Governments both of the United States and of Canada came to their rescue; but in the former country the urgency of the case was not at first fully comprehended, and before the necessary relief came many of the Indians perished from actual starvation. On the Canadian side, fortunately, the emergency was better understood. Arrangements were at once made for settling the Indians on reserves suited for agriculture, and for supplying them with food and clothing, and teaching them to erect wooden houses and cultivate their lands. The Indians displayed a remarkable readiness to adapt themselves to their new conditions. In 1880 the buffalo finally disappeared. In 1882, according to the official reports, more than half a million pounds of potatoes were raised by the three Blackfoot tribes, besides considerable quantities of oats, barley, and turnips. The Piegans had sold one thousand dollars' worth of potatoes, and had a large supply on hand. "The manner in which the Indians have worked," writes the agent, "is really astonishing, as is the interest they have taken and are taking in farming." Axes and other tools were distributed among them, and were put to good use. In November, 1882, the agent writes that log-houses "had gone up thick and fast on the reserves, and were most creditable to the builders." In many cases the logs were hewed, and in nearly all the houses fireplaces were built. In the same year another official, the Indian commissioner, going through the reserves, was surprised at the progress which he saw. He found comfortable dwellings, cultivated gardens, and good supplies of potatoes in root-houses. Most of the families had cooking-stoves, for which they had sometimes paid as much as fifty dollars. He "saw many signs of civilization, such as cups and saucers, knives and forks, coal-oil lamps, and tables; and several of the women were baking excellent bread, and performing other cooking operations." Three years before, these

Indians were wild nomads, who lived in skin tents, hunted the buffalo, and had probably never seen a plow or an axe.

The Blackfeet have been known to the whites for about a century, and during that period have dwelt in or near their present abode. There is evidence, however, that they once lived farther east than at present. Mackenzie, in 1789, found the three Blackfoot tribes, with their allies, the Fall Indians (or Atsinas), holding the South Branch of the Saskatchewan, from its source to its junction with the North Branch—a region of which the eastern portion was at a later day possessed by the Crees. Of the Blackfoot tribes, he says: "They are a distinct people, speak a language of their own, and I have reason to think are traveling northwest, as well as the others just mentioned (the Atsinas); nor have I heard of any Indians with whose language that which they speak has any affinity."

The result of Mr. McLean's inquiries confirms this opinion of the westward movement of these Indians in comparatively recent times. "The former home of these Indians," he writes, "was in the Red River country, where, from the nature of the soil which blackened their moccasins, they were called Blackfeet." This, it should be stated, is the exact meaning of *Siksika*, from *siksinam*, black, and *ka*, the root of *ohkatsh*, foot. The westward movement of the Blackfeet has probably been due to the pressure of the Crees upon them. The Crees, according to their own tradition, originally dwelt far east of the Red River, in Labrador and about Hudson Bay. They have gradually advanced westward to the inviting plains along the Red River, pushing the prior occupants before them by the sheer force of numbers. This will explain the deadly hostility which has always existed between the Crees and the Blackfeet.

Father Lacombe, it should be stated, is disposed to question the fact of the former residence of the Blackfeet in the Red River country, on the ground that their own tradition seems to bring them from the opposite direction. "They affirm," he writes, "that they came from the southwest, across the mountains; that is, from the direction of Oregon and Washington Territory. There were bloody conflicts between the Blackfeet and the Nez Percés, as Bancroft relates, for the right of hunting on the eastern slopes of the Rocky Mountains." Mr. McLean, who mentions the former residence of the Blackfeet in the Red River region as an undoubted fact, also says, "It is supposed that the great ancestor of the Blackfeet came across the mountains." Here are two distinct and apparently conflicting traditions which call for further inquiry. One of the best tests of the truth of tradition is to be found in language. Applying this test in the present instance, we are led to some interesting conclusions. It has been seen that Mackenzie, to whom we owe our first knowledge of the Blackfoot tribes, declared that their language had no affinity with that of any other Indians whom he knew. He was well acquainted with the Crees

and Ojibways, who speak dialects of the great Algonkin stock, but he recognized no connection between their speech and that of the Blackfeet. Later inquirers, and at first even Gallatin himself (after studying a brief list of Blackfoot words), took the same view. Subsequent investigations satisfied that distinguished philologist that his first impressions were incorrect, and that the Blackfoot language really belonged to the Algonkin stock. More recently the French missionaries have made the same discovery, "by studying," as M. Lacombe writes to me, "the grammatical rules of these languages." From the extensive comparative list of words and grammatical forms in the Blackfoot, Cree, and Ojibway languages, with which he has favored me, it appears that while the Blackfoot is in its grammar purely Algonkin, many of the most common words in its vocabulary are totally different from the corresponding words in the Algonkin tongues. Others which are found, on careful examination, to be radically the same as the corresponding Algonkin terms, are so changed and distorted that the resemblance is not at first apparent. These facts admit of but one explanation. They are the precise phenomena to which we are accustomed in the case of mixed languages. In such languages (of which our English speech is a notable example), we expect the grammar to be derived entirely from one source, while the words will be drawn from two or more. Furthermore, wherever we find a mixed language, we infer a conquest of one people by another. In the present instance, we may well suppose that when the Blackfoot tribes were forced westward from the Red River country to the foot of the Rocky Mountains, they did not find their new abode uninhabited. It is probable enough that the people whom they found in possession had come through the passes from the country west of those mountains. If these people were overcome by the Blackfeet, and their women taken as wives by the conquerors, two results would be likely to follow. In the first place, the language would become a mixed speech, in grammar purely Algonkin, but in the vocabulary largely recruited from the speech of the conquered tribe. A change in the character of the amalgamated people would also take place. The result of this change might be better inferred if we knew the characteristics of both the constituent races. But it may be said that a frequent if not a general result of such a mixture of races is the production of a people of superior intelligence and force of character.

The religion of these tribes (applying this term to their combined mythology and worship) resembles the language. It is in the main Algonkin, but includes some beliefs and ceremonies derived from some other source. In their view, as in that of the Ojibways, the Delawares, and other Algonkin nations, there were two creations—the primary, which called the world into existence, and the secondary, which found the world an expanse of sea and sky (with, it would seem, a few animals disporting themselves therein), and left it in its present state.

The primitive creation is attributed to a superior divinity, whom they call the Creator (*Apistotokin*), and sometimes identify with the sun. After this divinity—of whom their ideas are very vague—had created the watery expanse, another deity, with the aid of four animals, of which the muskrat was the chief, brought some earth from the bottom of the abyss, expanded it to the present continent, and peopled it with human beings. This deity is commonly styled by them the "Old Man" (*Napiw*), a name implying, as used by them, a feeling of affectionate admiration. He is represented as a powerful but tricksy spirit, half Jupiter and half Mercury. "He appears," writes M. Lacombe, "in many other traditions and legendary accounts, in which he is associated with the various kinds of animals, speaking to them, making use of them, and especially cheating them, and playing every kind of trick." In this being we recognize at once the most genuine and characteristic of all the Algonkin divinities. In every tribe of this wide-spread family, from Nova Scotia to Virginia, and from the Delaware to the Rocky Mountains, he reappears under various names—Manabozho, Michabo, Wetuks, Glooskap, Wisaketjak, Napiw—but everywhere with the same traits and the same history. He is at once a creator, a defender, a teacher, and at the same time a conqueror, a robber, and a deceiver. But the robbery and deceit, it would seem, are usually for some good purpose. He preserves mankind from their enemies, and uses the arts of these enemies to circumvent and destroy them. In Longfellow's charming poem, he is confounded with the Iroquois hero, Hiawatha. In Dr. Brinton's view, his origin is to be found in a Nature-myth, representing "on the one hand the unceasing struggle of day with night, light with darkness, and on the other that no less important conflict which is ever waging between the storm and sunshine, the winter and summer, the rain and clear sky."

Napiw, the "Old Man," has, it seems, other names in the Blackfoot tongue. He is known as Kenakatsis, "he who wears a wolf-skin robe," and Mik-orkayew, "he who wears a red-painted buffalo-robe." These names have probably some reference to legends of which he is the hero. The name of the Creator, Apistotokin, as explained by M. Lacombe, affords a good example of the subtile grammatical distinctions which abound in the Siksika, as in other Algonkin tongues. The expression "he makes," which, like other verbal forms, may be used as a noun, can be rendered in four forms, of varied shades of meaning: *Apistototsim* signifies "he makes," or "he who makes," when the complement, or thing made, is expressed, and is an inanimate object. *Apistotoyew* is used when the expressed object is animate. *Apistotakiw* is the indefinite form, used when the complement, or thing made, is not expressed, but is understood to be inanimate; and, finally, *Apistotokin*, the word in question, is employed when the unexpressed object is supposed to be animate. By this analysis we gain the unexpected

information that the world, as first created, was in the view of the Blackfoot cosmologists an animated existence.

But while these beliefs are all purely Algonkin, the chief religious ceremony of the Blackfoot tribes is certainly of foreign origin. This is the famous "Sun-dance," to which they, like the Dakota tribes and some of the Western Crees, are fanatically devoted. That this ceremony is not properly Algonkin is clearly shown by the fact that among the tribes of that stock, with the exception of the Blackfeet and a few of the Western Crees, it is unknown. Neither the Ojibways of the Lakes, nor any of the tribes east of the Mississippi, had in their worship a trace of this extraordinary rite. The late eminent missionary among the Dakotas, the Rev. Stephen R. Riggs (author of the "Dakota Grammar and Dictionary"), says of this ceremony: "The highest form of sacrifice is *self-immolation*. It exists in the Sun-dance, and is what is called "vision-seeking." Some, passing a knife under the muscles of the breast and arms, attach cords thereto, which are fastened at the other end to the top of a tall pole, raised for the purpose; and thus they hang suspended only by those cords, without food or drink, for two, three, or four days, gazing upon vacancy, their minds intently fixed upon the object in which they wish to be assisted by the deity, and waiting for a vision from above. Others, making incisions in the back, have attached, by hair ropes, one or more buffalo-heads, so that every time the body moves in the dance, a jerk is given to the buffalo-heads behind. The rite exists at present among the western bands of the Dakotas in the greatest barbarity. After making the cuttings in the arms, breast, or back, wooden setons—sticks about the size of a lead-pencil—are inserted, and the ropes are attached to them. Then, swinging on the ropes, they pull until the setons are pulled out with the flesh and tendons; or, if hung with buffalo-heads, the pulling is done in the dance, by successive jerks, keeping time with the music, while the head and body, in an attitude of supplication, face the sun, and the eye is unflinchingly fixed upon it."

A letter from the Rev. Mr. McLean furnishes a detailed and graphic account of this ceremony, as he witnessed it in June last, when most of the Kena or Blood Indians were present as actors or spectators. His narrative is too long for insertion here, but the concluding portion will show the resolute constancy with which this sacrifice of self-immolation is performed—some new features being added which are not comprised in Mr. Riggs's brief account, and possibly are not found among the Dakotas:

"This year, several persons, young and old, who had made vows during times of sickness or danger, had a finger cut off at the first joint, as an offering to the sun; and others had the operation of cutting their breasts and backs. The old woman who cut the fingers off held the suppliant's hand up to the sun, and prayed—then placed it upon a pole on the ground, laid a knife on the finger, and with a blow

from a deer-horn scraper severed the member. The severed piece was taken up, held toward the sun, and the prayer made, when it was dropped into a bag containing similar members. This ceremony was gone through with each in turn. After this was done, each carried an offering, and climbing the sacrificial pole, with the face reverently turned toward the sun, placed the offering on the top of the pole. This year seven or eight persons went through the above ceremony. The other sacrificial ceremony consisted of the slitting of the flesh in two pieces in each breast. A wooden skewer was thrust through each breast, a rope fastened to the sacrificial pole was placed around each skewer, and then the suppliant—whistling all the time upon the bone whistle—jumped about until the flesh gave way. In some instances the flesh was cut so deeply that two men had to press upon the performer's shoulders in order to tear it away. The 'shield ceremony' was the same process, only performed on the back, and the rope with a shield attached fastened to the skewers, and the ceremony continued until the suppliant was released."

Mr. Riggs, it will be noticed, says that the ceremony was most zealously performed among the most westerly of the Dakota tribes, that is, those which are nearest to the Rocky Mountains and to the Blackfeet. Possibly the Blackfeet may have learned the rite from the tribe from which they acquired the foreign element of their language, and may have taught it to the Western Dakotas and Crees. In any case, it is clear that they have a mixed religion as well as a mixed language—which are both facts of considerable interest in ethnological science.

The form of government among the Blackfeet, as among the Algonkin tribes generally, is exceedingly simple, offering a striking contrast to the elaborately complicated system common among the nations of the Iroquois stock. Each tribe has a head chief, and each of the bands composing the tribe has its subordinate chief ; but the authority of these chiefs is little more than nominal. The office is not hereditary, the bravest or richest being usually chosen. The term "confederacy," commonly applied to the union of the Blackfoot tribes, is somewhat misleading. There is no regular league or constitution binding them together. "They consider themselves," writes M. Lacombe, "as forming one family, whose three branches or bands are descended from three brothers. This bond of kinship is sufficient to preserve a good understanding among them." They can hardly be said to have a general name for their whole community, though they sometimes speak of themselves as Sawketapix, or "Men of the Plains," and occasionally as Netsepoyè, or "People who speak one language."

The facts thus derived from the best authorities concerning this interesting people suggest some important conclusions. The opinion, still entertained by many, of the impossibility of bringing the nomadic Indians—or at least the grown-up people—under the restraints of civ-

ilization, has certainly not proved correct in this case, where we see a large body of wandering hunters converted within three years into a community of industrious and successful farmers. If it be said that the Blackfeet are, to some extent, an exceptional people, we are led to inquire into the origin of their superiority; and we can find no other cause than the fact that they are evidently a people of mixed race. As the Chilians, who are of mingled Spanish and Araucanian origin, are taking the lead among the nations of South America—as the Feejeeans, who are of mixed Polynesian and Melanesian race, are foremost in mental vigor among the islanders of the South Pacific—so it would seem that the Blackfeet may owe their unusual capacity for improvement to a like cause. Instead of holding the melancholy belief which was common a few years ago—but which science is now repudiating—that Nature is opposed to a mingling of the human races, we may find in such evidences reason to believe that Nature is preparing to produce, by a commixture of the most opposite races, the most progressive, and possibly the predominant, race of the future.

RAFINESQUE.*

By Professor DAVID STARR JORDAN.

IT is now nearly seventy years since the first student of our fishes crossed the Falls of the Ohio and stood on Indiana soil. He came on foot, with a note-book in one hand and a hickory stick in the other, and his capacious pockets were full of wild flowers, shells, and toads. His mantle (since fallen upon me) was "a long, loose coat of yellow nankeen, stained yellower by the clay of the roads, and variegated by the juices of plants." In short, in all respects of dress, manners, and appearance, he would be described by the modern name of "tramp."

Nevertheless, no more remarkable figure has ever appeared in the annals of science or in the annals of Indiana. To me it has always possessed a peculiar interest, and so, for a few moments, I wish to call up before you the figure of Rafinesque, with his yellow nankeen coat, "his sharp, tanned face, and his bundle of plants, under which a peddler would groan," before it wholly recedes into the shadows of oblivion.

Constantine Samuel Rafinesque was born in Constantinople, in the year 1784. His father was a French merchant from Marseilles doing business in Constantinople, and his mother was a German girl born in Greece, of the family name of Schmaltz. Rafinesque himself, son of a Franco-Turkish father and a Græco-German mother, was an American.

Before he was a year old his life-long travels began, his parents

* Read before the Indiana Academy of Sciences, December 30, 1885.

visiting ports of Asia and Africa on their way to Marseilles. As a result of this trip, we have the discovery, afterward duly announced by him to the world, that "infants are not subject to sea-sickness."

At Marseilles his future career was determined for him; or, in his own language: "It was among the flowers and fruits of that delightful region that I first began to enjoy life, and I became a botanist. Afterward, the first prize I received in school was a book of animals, and I am become a zoölogist and a naturalist. My early voyage made me a traveler. Thus, some accidents or early events have an influence on our fate through life, or unfold our inclinations." *

Rafinesque now read books of travel, those of Captain Cook, Le Vaillant, and Pallas especially, and his soul was fired with the desire "to be a great traveler like them. . . . And I became such," he adds shortly. At the age of eleven he had begun an herbarium, and had learned to read the Latin in which scientific books of the last century were written. "I never was in a regular college," he says, "nor lost my time on dead languages, but I spent it in reading alone, and by reading ten times more than is read in the schools. I have undertaken to read the Latin and Greek, as well as the Hebrew, Sanskrit, Chinese, and fifty other languages, as I felt the need or inclination to study them."

At the age of twelve he published his first scientific paper, "Notes on the Apennines," as seen from the back of a mule on a journey from Leghorn to Genoa. Rafinesque was now old enough to choose his calling in life, and he decided to become a merchant, for, said he, "commerce and travel are linked." At this time came the first outbreaks of the French Revolution, and the peasants of Provence began to dream of "castles on fire and castles combustible," so Rafinesque's prudent father sent his money out of France and his two sons to America.

In Philadelphia Constantine Rafinesque became a merchant's clerk, and his spare time was devoted to the study of botany. He tried also to study the birds, but he says, "The first bird I shot was a poor chickadee, whose death appeared a cruelty, and I never became much of a hunter." During his vacations Rafinesque traveled on foot over parts of Pennsylvania and Virginia. He visited President Jefferson, who, he tells us, asked him to call again. In 1805, receiving an offer of business in Sicily, Rafinesque returned to Europe. He spent ten years in Sicily, the land, as he sums it up, "of fruitful soil, delightful climate, excellent productions, perfidious men, and deceitful women." Here in Sicily he discovered the medicinal squill, which, aided by the equally medicinal paregoric, was once the chief delight of childhood. He commenced gathering this in large quantities for shipment

* This and most of the other verbal quotations in this paper are taken from an "Autobiography of Rafinesque," of which a copy exists in the Library of Congress. A few quotations have been somewhat abridged.

to England and Russia. The Sicilians thought that he was using it as a dye-stuff, and this, said he, "I let them believe." Nearly two hundred thousand pounds had been shipped by him before the secret of the trade was discovered, since which time the Sicilians have prosecuted the business on their own account. He began to turn his attention to the animals of the sea, and here arose his passion for ichthyology. All the red-shirted Sicilian fishermen brought to him the strange creatures which came in their nets. In 1810 he published two works on the fishes of Sicily, and for our first knowledge of very many of the Mediterranean fishes we are indebted to these Sicilian papers of Rafinesque.

It is unfortunately true, however, that very little real gain to science has come through this knowledge. Rafinesque's descriptions in these works are so brief, so hasty, and so often drawn from memory, that later naturalists have been put to great trouble in trying to make them out. A peculiar, restless, impatient enthusiasm is characteristic of all his writings, the ardor of the explorer without the patience of the investigator.*

In Sicily, Rafinesque was visited by the English ornithologist. William Swainson. Swainson seems to have been a great admirer of "the eccentric naturalist," and of him Rafinesque says: "Swainson often went with me to the mountains. He carried a butterfly-net to catch insects with, and was taken for a crazy man or a wizard. As he hardly spoke Italian, I had once to save him from being stoned out of a field, where he was thought to seek a treasure buried by the Greeks." Rafinesque now invented a new way of distilling brandy. He established a brandy-distillery, where, said he, "I made a very good brandy, equal to any made in Spain, without ever tasting a drop of it, since I hate all strong liquors. This prevented me from relishing this new employment, and so I gave it up after a time."

Finally, disgust with the Sicilians, and fear of the French wars, caused Rafinesque, who was, as he says, "a peaceful man," to look again toward the United States. In 1815 he sailed again for America, with all his worldly goods, his reams of unpublished manuscripts, his bushels of shells, and a multitude of drawings of objects in natural history. According to his own account, the extent of his collections at that time was enormous, and from the great number of scattered treatises on all manner of subjects which he published in later years, whenever he could get them printed, it is fair to suppose that his pile of manuscripts was equally great. A considerable number of his note-books, and of papers for which, fortunately for scientific nomenclature, he failed to find a publisher, are now preserved in the United States National Museum. These manuscripts are remarkable for two

* Dr. Elliott Coues has wittily suggested that as the words "gro*tesque*," "pictur*esque*," and the like, are used to designate certain literary styles, the adjective "rafin*esque*" may be similarly employed for work like that of the author now under consideration.

things—the beauty of the quaint French penmanship and the atrocious badness of the accompanying drawings.

His numerous note-books, written in French, represent each the observations of a busy summer, and these observations, for the most part unchecked by the comparison of specimens, were by him prepared for the press during the winter. To this manner of working, perhaps unavoidable in his case, many of Rafinesque's errors and blunders are certainly due. In one of these note-books I find, among a series of notes in French, the following remarkable observation in English: "*The girls at Fort Edward eat clay!*" In another place I find a list of the new genera of fishes in Cuvier's "Règne Animal" (1817) which were known to him. Many of these are designated as synonymous with genera proposed by Rafinesque in his "Caratteri" in 1810. With this list is the remark that these genera of Cuvier are identical with such and such genera "proposed by me in 1810, but don't you tell it!"

Rafinesque was six months on the ocean in this second voyage to America; and finally, just as the ship was entering Long Island Sound, the pilot let her drift against one of the rocks which lie outside of the harbor of New London. The vessel filled and sank, giving the passengers barely time to escape with their lives. "I reached New London at midnight," says Rafinesque, "in a most deplorable situation. I had lost everything—my fortune, my share in the cargo, my collections and labors of twenty years past, my books, my manuscripts, and even my clothes—all I possessed, except some scattered funds and some little insurance-money. Some hearts of stone have since dared to doubt of these facts, or rejoice at my losses. Yes, I have found men vile enough to laugh without shame at my misfortunes, instead of condoling with me. But I have met also with friends who have deplored my loss and helped me in need."

I shall pass rapidly over Rafinesque's career until his settlement in Kentucky. He traveled widely in America, in the summer, always on foot. "Horses were offered to me," he said, "but I never liked riding them, and dismounting for every flower. Horses do not suit botanists." He now came westward, following the course of the Ohio, and exploring for the first time the botany of the country. He came to Indiana, and for a short time was associated with the community then lately established by Owen and Maclure at New Harmony, on the Wabash. Though this New Harmony experiment was a failure, as all communities must be in which the drone and the worker alike have access to the honey-cells, yet the debt due it from American science is very great. Although far in the backwoods, and in the long notorious county of Posey, New Harmony was for a time fairly to be called the center of American science, and even after half a century has gone by its rolls bear few names brighter than those of Thomas Say, David Dale Owen, and Charles Le Sueur.

Rafinesque soon left New Harmony, and became Professor of Natural History and the Modern Languages in Transylvania University, at Lexington, Kentucky. He was, I believe, the very first teacher of natural history in the West, and his experiences were not more cheerful than those of most pioneers. They would not give him at Lexington the degree of Master of Arts, he says, "because I had not studied Greek in a college, although I knew more languages than all the American colleges united, but it was granted at last; but that of Doctor of Medicine was not granted, because I would not superintend anatomical dissections.

"Mr. Holley, the president of the university, despised and hated the natural sciences, and he wished to drive me out altogether. To evince his hatred against science and its discoveries, he had broken open my rooms in my absence, given one to the students, and thrown all my effects, books, and collections, into the other. He had deprived me of my situation as librarian, and tried to turn me out of the college. I took lodgings in town," said he, "and carried there all my effects, leaving the college with curses both on it and Holley, which reached them both soon after, for Holley died of the yellow fever in New Orleans, and the college was burned with all its contents."

In one of his summer trips Rafinesque became acquainted with Audubon, who was then painting birds and keeping a little "grocery-store" down the river, at Hendersonville, Kentucky. Rafinesque reached Hendersonville in a boat, carrying on his back a bundle of plants which resembled dried clover. He accidentally met Audubon, and asked him to tell him where the naturalist lived. The ornithologist introduced himself, and Rafinesque handed him a letter from a friend in the East, commending him to Audubon as an "odd fish, which might not be described in the published treatises." The story of the interview is thus described by Audubon: "His attire struck me as exceedingly remarkable. A long, loose coat of yellow nankeen, much the worse for the many rubs it had got in its time, hung about him loosely, like a sack. A waistcoat of the same, with enormous pockets and buttoned up to the chin, reached below over a pair of tight pantaloons, the lower part of which was buttoned down over his ankles. His beard was long, and his lank black hair hung loosely over his shoulders. His forehead was broad and prominent, indicating a mind of strong power. His words impressed an assurance of rigid truth, and as he directed the conversation to the natural sciences, I listened to him with great delight.

"That night, after we were all abed, I heard of a sudden a great uproar in the naturalist's room. I got up and opened the door, when to my astonishment I saw my guest running naked, holding the handle of my favorite violin, the body of which he had battered to pieces in attempting to kill the bats which had entered the open window! I stood amazed, but he continued jumping and running around and

around till he was fairly exhausted, when he begged me to procure one of the animals for him, as he felt convinced that they belonged to a new species. Although I was convinced of the contrary, I took up the bow of my demolished violin, and giving a smart tip to each bat as it came up, we soon had specimens enough."

A part of the story of this visit, which Audubon does not tell, may be briefly related here : Audubon was a great artist, and his paintings of birds and flowers excited the wonder and admiration of Rafinesque, as it has that of the generations since his time. But Audubon was something of a wag withal, and some spirit of mischief led him to revenge the loss of his violin on the too ready credulity of his guest. He showed him gravely some ten grotesque drawings of impossible fishes which he had observed "down the river," with notes on their habits, and a list of the names by which they were known by the French and the English settlers. These Rafinesque duly copied into his note-books, and later he published descriptions of them as representatives of new genera, such as *Pogostoma*, *Aplocentrus*, *Litholepis*, *Pilodictis*, and the like.

These singular genera, so like and yet so unlike to anything yet known, have been a standing puzzle to students of fishes. Various attempts at identification of them have been made, but in no case have satisfactory results been reached. Many of the hard things which have been said of Rafinesque's work rest on these unlucky genera, "communicated to me by Mr. Audubon." The true story of this practical joke was told me by the venerable Dr. Kirtland, who in turn received it from Dr. Bachman, the brother-in-law and scientific associate of Audubon. In the private note-books of Rafinesque I have since found his copies of these drawings, and a glance at these is sufficient to show the extent to which science through him has been victimized.

About this time Rafinesque turned his mind again toward invention. He invented the present arrangement of coupon bonds, or, as he called it, "the divitial invention." Savings-banks were projected by him, as well as "steam plows," "aquatic railroads," fire-proof houses, and other contrivances which he was unable to perfect. He took much delight in the study of the customs and languages of the Indians. In so doing, if the stories are true, he became, in a measure, one of the ancestors of Mormonism ; for it is said that his suggestion that the Indians came from Asia by way of Siberia, and were perhaps the descendants of the ten lost tribes of Israel, gave the first suggestion to Solomon Spalding, on which he built his book of the prophet Mormon. In any case, whether this be true or not, it is certain that Rafinesque is still cited as high authority by the Latter-day Saints when the genuineness of the book of Mormon is questioned.

Rafinesque now returned to Philadelphia and published "The Atlantic Journal and Friend of Knowledge," "Annals of Nature," and other serials, of which he was editor, publisher, and usually sole con-

tributor. After a time he became sole subscriber also, a condition of affairs which greatly exasperated him against the Americans and their want of appreciation of science. He published several historic treatises, and contemplated a "Complete History of the Globe," with all its contents. An elaborate poem of his, dreary enough, is entitled "The World, or Instability." He made many enemies among the American botanists of his time by his overbearing ways, his scorn of their customs and traditions, and especially by his advocacy of crude and undigested though necessary reforms, so that at last most of them decided to ignore his very existence. In those days, in matters of classification, the rule of Linnæus was supreme, and any attempt to recast his artificial groupings was looked at as heretical in the extreme. The attempt at a natural classification of plants, which has made the fame of Jussieu, had the full sympathy of Rafinesque, but to his American contemporaries such work could lead only to confusion. Then, again, in some few of its phases, Rafinesque anticipated the modern doctrine of the origin of species. That the related species of such genera as *Rosa*, *Quercus*, *Trifolium* have had a common origin, a view the correctness of which no well-informed botanist of our day can possibly doubt, Rafinesque then maintained against the combined indignation and disgust of all his fellow-workers. His writings on these subjects read better to-day than when, forty-five years ago, they were sharply reviewed by one of our then young and promising botanists, Dr. Asa Gray.

But the botanists had good reason to complain of the application of his theories of evolution. To Rafinesque, the production of a new species was a rapid process—a hundred years was time enough—and, when he saw the tendency in diverging varieties toward the formation of new species, he was eager to anticipate Nature (and his fellow-botanists as well), and give it a new name. He became a sort of monomaniac on the subject of new species. He was uncontrolled in this matter by the influence of other writers, that incredulous conservatism as to one another's discoveries which furnishes a salutary balance to enthusiastic workers. Before his death, so much had he seen, and so little had he compared, that he had described certainly twice as many fishes, and probably nearly twice as many plants and shells, also, as really existed in the regions over which he traveled. He once sent for publication a paper describing, in regular natural history style, twelve new species of thunder and lightning which he had observed near the Falls of the Ohio!

Then, too, Rafinesque studied in the field, collecting and observing in the summer, comparing and writing in the winter. When one is chasing a frog in a canebrake, or climbing a cliff in search of a rare flower, he can not have a library and a museum at his back. The exact work of our modern museums and laboratories was almost unknown in his day. Then, again, he depended too much on his memory

for facts and details, and, as Professor Agassiz used to say, "the memory must not be kept too full, or it will spill over."

Thus it came about that the name and work of Rafinesque fell into unmerited neglect. His writings, scattered here and there in small pamphlets, cheap editions published at his own expense, had been sold as paper-rags, or used to kindle fires by those to whom they were sent, and later authors could not find them. His "Ichthyologia Ohioensis," once sold for a dollar, is now quoted at fifty dollars, and the present writer has seen but two copies of it. In the absence of means to form a just opinion of his work, it became the habit to pass him by with a sneer, as the "inspired idiot" "whose fertile imagination has peopled the waters of the Ohio."

Until lately, only Professor Agassiz * has said a word in mitigation of the harsh verdict passed on Rafinesque by his fellow-workers and their immediate successors. Agassiz says, very justly: "I am satisfied that Rafinesque was a better man than he appeared. His misfortune was his prurient desire for novelties, and his rashness in publishing them. . . . Tracing his course as a naturalist during his residence in this country, it is plain that he alarmed those with whom he had intercourse, by his innovations, and that they preferred to lean upon the authority of the great naturalist of the age [Cuvier], who, however, knew little of the special history of the country, rather than to trust a somewhat hasty man who was living among them, and who had collected a vast amount of information from all parts of the States upon a variety of subjects then entirely new to science." †

In a sketch of "A Neglected Naturalist," Professor Herbert E. Copeland has said: "To many of our untiring naturalists, who sixty years ago accepted the perils and privations of the far West, to collect and describe its animals and plants, we have given the only reward they sought, a grateful remembrance of their work. Audubon died full of riches and honor, with the knowledge that his memory should be cherished as long as birds should sing. Wilson is the 'father of American ornithology,' and his mistakes and faults are forgotten in our admiration of his great achievements. Le Sueur is remembered as the 'first to explore the ichthyology of the great American lakes.' Laboring with these, and greatest of them all in respect to the extent and range of his accomplishments, is one whose name has been nearly forgotten, and who is oftenest mentioned in the field of his best labors with pity or contempt." ‡

It is doubtless true; while, as Professor Agassiz has said, Rafi-

* So early as 1844, Professor Agassiz wrote to Charles Lucien Bonaparte: "I think that there is a justice due to Rafinesque. However poor his descriptions, he first recognized the necessity of multiplying genera in ichthyology, and this at a time when the thing was far more difficult than now."

† Agassiz, "American Journal of Science and Arts," 1854, p. 354.

‡ "American Naturalist," 1876.

nesque "was a better man than he appeared," and while he was undoubtedly a man of great learning and of greater energy, his work does not deserve a high place in the records of science. And his failure seems due to two influences: first, his lack of attention to details, a defect which has vitiated all of his work; and, second, his versatility, which led him to attempt work in every field of learning.

As to this, he says himself: "It is a positive fact that in knowledge I have been a botanist, naturalist, geologist, geographer, historian, poet, philosopher, philologist, economist, philanthropist. By profession a traveler, merchant, manufacturer, brewer, collector, improver, teacher, surveyor, draughtsman, architect, engineer, palmist, author, editor, bookseller, librarian, secretary, and I hardly know what I may not become as yet, since, whenever I apply myself to anything which I like, I never fail to succeed, if depending on myself alone, unless impeded or prevented by the lack of means, or the hostility of the foes of mankind."

"The one prudence in life," says Emerson, "is concentration; the one evil, dissipation."

But a traveler Rafinesque chiefly considered himself, and to him all his pursuits, scientific, linguistic, historic, were but episodes in a life of travel. Two lines of doggerel French were his motto:

> "Un voyageur dès le berceau,
> Je le serai jusqu' au tombeau."

> "A traveler from the cradle,
> I'm a traveler to the tomb."

Long before the invention of railroads and steamboats, he had traveled over most of Southern Europe and Eastern North America. Without money except as he earned it, he had gathered shells and plants and fishes on every shore from the Hellespont to the Wabash. He was the frontiersman of our natural history, the Daniel Boone of American science.

Concerning one element of Rafinesque's character I am able to find no record. If he ever loved any man or woman, except as a possible patron and therefore aid to his schemes of travel, he himself gives no record of it. He speaks kindly of Audubon, but Audubon had furnished him with specimens and paintings of flowers and fishes. He speaks generously of Clifford, at Lexington, but Clifford had given him an asylum when he was turned out of Transylvania University. No woman is mentioned in his autobiography except his mother and sister, and these but briefly. His own travels, discoveries, and publications, filled his whole mind and soul.

Rafinesque died in Philadelphia, in 1840, at the age of fifty-six. He had been living obscurely in miserable lodgings in an unfriendly garret, for his dried plants, and his books published at his own expense, brought him but a scanty income. His scientific reputation had not

reached his fellow-lodgers, and his landlord thought him "a crazy herb-doctor." He died alone, and left no salable assets, and his landlord refused to allow his friends—such friends as he had—to enter the house to give him a decent burial. He wished to make good the unpaid rent by selling the body to a medical college. But at night, so the story goes, a physician who had studied botany with Rafinesque got a few friends together, and broke into the garret and carried away the body, which they buried in a little churchyard outside the town, now obliterated by the growth of Philadelphia.

American naturalists have greater honor now than forty years ago. Rafinesque died unnoticed and was buried only by stealth. A whole nation wept for Agassiz. But a difference was in the men as well as in the times. Both were great naturalists and learned men. Both had left high reputations in Europe to cast their lot with America. Agassiz's great heart went out toward every one with whom he came in contact. But Rafinesque loved no man or woman, and died, as he had lived, alone.

If some loving hand had followed him to the last, it might have been with Rafinesque as with Albrecht Dürer: "'*Emigravit*' is the inscription on the headstone where he lies." But there was no such hand, and there is neither headstone nor inscription, and we know not even the place where he rests after his long journey.

COUNTING UNCONSCIOUSLY.

By Professor W. PREYER,
OF THE UNIVERSITY OF JENA.

AT first sight the superscription, "counting unconsciously," seems to contain a contradiction. For, whoever counts from one to one hundred, realizes at each number, that he is counting; yet, in truth, there are so many instances where an educated person counts without realizing it, that he would feel utterly lost in this world should this faculty be suddenly taken from him.

Three coins being placed on a table, any one will, on being asked, "How many are there?" answer, after but a glance, "Three." Even when four or five coins are seen but for a moment, the answer as to their number will be correctly given. So quickly is the answer returned that no time can possibly have been taken for counting. Hence, it follows that counting unconsciously is really an every-day occurrence. The objection that this is no longer to be termed counting, is not valid; for if any one can positively state that there are lying before him three, or four, or five objects, he must be able to distinguish numbers; and it is certainly a fact that one who can not count, can also not answer such questions. Children, in order to dis-

tinguish three marbles from four, must first add each marble to the other; in this way many learn to count before knowing the numerals. From this it follows that, in order to count, a knowledge of the numerals is not a necessity; even untrained deaf-mutes, who can neither read nor write, are capable of counting, without figures, merely by the aid of their fingers.

From the action of a child who has learned the meaning of the numerals, it furthermore follows that it is only by practice, that is by oft-repeated counting of actual objects, that surety is gained in the art of counting small numbers unconsciously. An idiot, or whoever does not practice, can not count three without adding one by one, and will never rise above the lowest plane of mental development.

Now, however, as is well known, no one can tell in a moment how many objects are lying before him, provided the number of these objects is somewhat large—approximates, say, fifty. Some persons can count more rapidly than others; a broker's apprentice will make groups of three, of five, of ten coins, and then add the groups together; the experienced money-broker is able to determine in a few seconds what the amount is, and this, perhaps, without even touching the coins. But he too, as well as every one else, must count attentively as soon as the number of pieces exceeds a certain limit. But what is this limit?

Dase, the well-known calculator, who died in 1861, stated that he could distinguish some thirty objects of a similar nature in a single moment as easily as other people can recognize three or four, and his claim was often verified by tests. The rapidity with which he would name the number of sheep in a herd, of books in a book-case, of window-panes in a large house, was even more remarkable than the accuracy with which he solved mentally the most difficult problems. Not before or after his time has such perfection been attained; but as every one possesses this faculty to a small extent, and as it can be improved by practice, it is not impossible that in future other experts in this line may appear. The only trouble is that so few know how easy it is to practice.

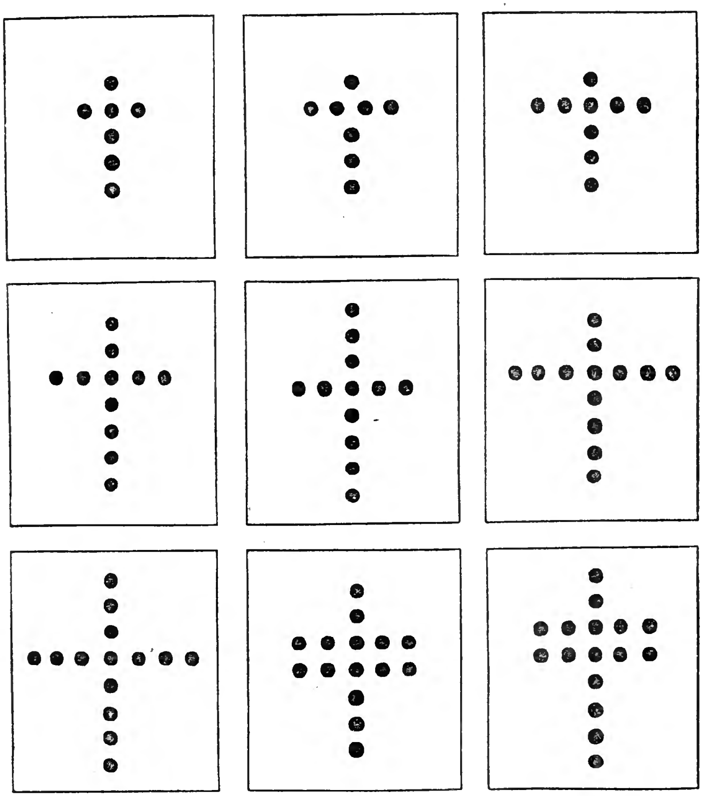
In the first place, one can by a few trials readily gain the conviction that, without practice, not every one can distinguish six and seven objects as easily as three and four.

In order to learn that it is a comparatively easy matter to estimate up to six and seven, and then up to nine, as correctly as from three to five, one need only make a few trials in guessing at an unknown number of matches or pins that are concealed beneath a sheet of paper, and are then exposed to view but for a second.

Great care must be exercised, however, that one does not consciously count in these attempts; nor will it answer to attempt analysis from memory, after the objects are again hidden from view; all this would consume too much time. It is, in fact, necessary to do

nothing more than to *estimate*, but this must be done with the utmost attention.

Whoever has for any length of time tried seriously to guess correctly will be surprised to find that his guesses will soon grow to be generally correct, whereas at the start they were often erroneous. Only when the number of objects seen exceeds nine will mistakes again occur more frequently. However, further practice in estimating greater numbers of small objects will soon cause considerable improvement even here. Many, however, do not succeed in estimating correctly beyond ten, probably because the attention is not sufficiently concentrated at the time, and as it is necessary, at the start at least, that one's whole attention be closely given ; only after having attained some degree of proficiency will the exercise of this power no longer prove fatiguing.



In order to practice this kind of counting, dots and small circles were drawn on white paper squares. Some of these dots were arranged symmetrically, others were irregularly placed. These were glanced at for a moment, and proved of considerable aid in acquiring the art. A good deal depends on the arrangement of the dots. A card-player

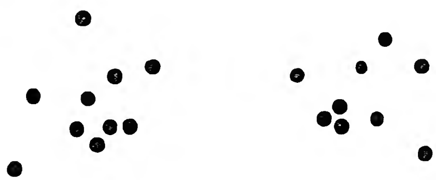
will immediately, and without stopping to count, realize that there are ten hearts on a ten-spot of that suit, but he will not be able to give as correctly the number of hearts or of dots if thesebe arranged, for instance, in the form of a cross.

Hence it follows that it is not the symmetry of arrangement that facilitates the estimating, but acquaintance with the manner of arrangement used.

It is more difficult to correctly estimate the number of dots arranged in the form of a cross than to determine them if arranged as on cards and in similar ways.

It is more easy to estimate the dots if arranged as on dominoes; the dots must not be too small, and must be made a deep black on a white ground, or the reverse.

The estimation of the number of dots is most difficult if they are grouped in an irregular manner, as, for instance, in the following figures:



Practice, which is naught but patient and correct repetition, will, however, even here make perfect. However, it may be regarded as proved by the case of Dase, before referred to, that practice, however long continued, can not aid beyond a certain limit. It seems that, for the rapid estimation or the unconscious counting of dots placed in unknown symmetrical arrangement, and for objects grouped into irregular forms, twenty is the limit.

Probably already, when the number of the objects exceeds twenty—undoubtedly, when it exceeds thirty—accuracy in estimating can no longer be attained, even after the greatest amount of practice, in which Dase for one certainly was not wanting.

However, this is not to say that more than thirty dots can not, under any circumstances, be simultaneously determined; but in order that this may be done they must be presented in some well-known manner of arrangement, which must, as it were, have been fairly learned by heart. Thus, very skillful card and domino players are able at a glance to take in as many as forty points, in nines, tens, fives, sixes, etc. This they do so rapidly as not to be conscious of any addition. But in such cases it is no longer the seeing of single dots, but seeing the pictures they form, which makes the feat possible. As no one on seeing the number 8 will count from one to eight, so no card-player will stop to count on seeing an eight of hearts, for instance. A child, however, not yet familiar with the appearance of cards, will count each heart separately, perhaps even touching each one in turn with his finger.

In order to quickly attain the faculty of counting unconsciously, a

book may be used to advantage. If one takes a book, opens the same—the eyes to be kept closed in the mean time—and then casts a rapid glance at a part of the page and tries to estimate how many lines are visible, this way of doing, if often repeated and always tried on different pages, will soon conduce to great accuracy in estimating. A small child is not able to estimate even three lines correctly, though looking at them for fully a second.

As the mind develops, it acquires a more simple and rapid process of counting. Something that at first had to be undertaken slowly and with care, perhaps in separate stages, may later on be accomplished much more quickly and without requiring any special effort, or calling for any great amount of attention, in fact almost "mechanically."

One is fully conscious of every perfectly new impression received by the brain; hence the fascination of a novel idea. The more the charm of novelty fades with the recurrence of the same sensation, the less will consciousness be called into play.

Counting from one upward, by constant repetition, finally comes to be done unconsciously, even as the quick movement of the fingers in practicing on the piano gradually becomes almost automatic, though at first this, too, required great care and attention. In all similar cases consciousness is no longer called into play.

An impression that seemed most startling when first received may, if too often repeated, grow to be trivial. The simple work of counting finally comes to be an unconscious action of the nerve-fibers and cells of the brain.

On newly built roads, the trains are run but slowly; the longer such roads have been used, the more rapidly are trains run on them, and stops at way-stations are no longer needed; it is even thus with the trains of thought in the human brain.

And on this rests the practical importance of rapid counting. Whoever can, unconsciously but correctly, count up to twenty or even only up to twelve, has a great advantage over others who can not, without error, distinguish six from seven in this manner. For such a one can turn his consciousness to other matters and greatly increase his knowledge, where another would make but slow progress.

Those movements in man, which take place through some impression received from without and not aided by any conscious act of the brain (as, for instance, the contracting of the pupil when a bright light strikes the eye), are termed reflex actions.

In part these are brought about by arbitrary but oft-repeated motions, inasmuch as such will gradually take place more rapidly and without premeditation.

In this way, through practice, counting from one to five is done unconsciously, and somewhat resembles a reflex action.

If many such simple mental acts (by the repetition of which noth-

ing new is learned, and time only is lost) could be caused to pass off more rapidly—somewhat resembling reflex actions—the brain would be left free to turn to other, to higher aims.—*Translated for the Popular Science Monthly from Die Gartenlaube.*

THE MILLENNIUM OF MADNESS.

By FELIX L. OSWALD.

In a recent number of "The Popular Science Monthly" Professor McElroy's brilliant essay on the cause and cure of feudalism was prefaced by a question which has, indeed, been but rarely investigated from a scientific point of view. The debasement of the noblest Caucasian nations during the thousand years following the day when the power of Rome collapsed under the blows of the freedom-loving Goths seems certainly the most striking anomaly in the history of mankind. Yet would it have been well for those nations if their debasement had been confined to that loss of personal liberty which in pagan Greece and Rome followed the ascendency of a military despotism. But how shall we account for the fact that in mediæval Europe that loss was accompanied by a general neglect of science and education, a general decadence of industry, and a wide-spread epidemic of monstrous superstitions? Thus supplemented, Professor McElroy's question expresses the great enigma of the middle ages—an enigma which can not be wholly explained by the "adaptation of the horse to warfare and the development of defensive armor."

The doctrine of evolution recognizes the fact that the development of social and physical organisms is not an unbroken march of progress. Advancement alternates with pauses, as day with night, or life with death; the phenomena of progressive life roll through the cycles of germination, maturity, and decay. In the household of Nature every grave is a cradle; the mold of every fallen tree furthers the growth of new trees. Grecian colonies flourished on the ruins of Troy, Persian provinces on the ruins of Babylon, Macedonian kingdoms on the grave of the Persian Empire; Roman legionaries inherited the wealth and the culture of conquered Greece. The conquerors of Rome were the noblest, stoutest, and manliest races of the Caucasian world; freemen, in love with health and Nature, yet withal with poetry, glory, honor, justice, and honest thrift. They planted their banners in the garden-lands of the West; and their empires, gilt by the morning light of a new era, were founded under auspices far happier than those of the Arabian satrapies in the worn-out soil of the East. In less than five hundred years after the establishment of their political independence, the civilization of the Greeks, the Romans, and the Arabs, had developed its fairest flowers—industry, commercial activity, art, liberal

education, flourishing schools of philosophy, poetry, and natural science. Five hundred years after the triumph of the Gothic conquerors we find their empires groaning under a concentration of all scourges. The day-star of civilization had set in utter night; the proud nations of the West had sunk in poverty, bigotry, general ignorance, cruel abasement of the lower classes, squalid misery of domestic life, systematic suppression of political, personal, and intellectual liberty.

How shall we explain that dreadful *aphanasia*, that thousand years' eclipse of reason and freedom that followed like an unnatural night upon the brightest sunrise in the history of the human race? A year after the death of the prophetess Sospitra, says the pagan historian Eunapius, her son was one day standing before the temple of Serapis, when the prophetic spirit of his mother fell upon him: "Woe be our children!" he exclaimed, when he awakened from his trance; "I see a cloud approaching: a great darkness will fall upon the human race."

And, verily, that cloud did not come from Olympus or Mount Sinai. The law revealed in the "conservation of forces" holds good in many phenomena of the moral world. Every apparent annihilation of energy is only a metamorphosis of its manifestations, and we can often discover the principle of that metamorphosis by ascertaining the active concomitants of its results. Just as mechanical force can be converted into heat, or heat into electricity, the energy diverted from rural pursuits may assert itself in political, industrial, or scientific activity. The pent-up vigor of the middle ages had no such outlets. War, now a curse, was then a welcome, but limited, alternative of stagnation; the lethargy of the dreary intervals was for millions a night without even the starlight of hope. Yet that strange torpor was accompanied by the feverish activity of a novel pursuit—a relentless war against the instincts of Nature. The children of freedom-loving ancestors were imprisoned in convents, where bigotry and superstition conspired for the suppression of every natural feeling. Hordes of self-torturing fanatics roamed the land, appalling the wretched peasants by their direful predictions of approaching calamities. Fourteen different orders of monastic devotees vied in the systematic mortification of their natural desires, the depletion of their physical and intellectual vigor, the enforcement of health-destroying penances, and reason-insulting dogmas and ceremonies. While science withered to its very roots in the famished love of knowledge, the mania of *antiphysics* rioted in the production of thousands upon thousands of voluminous manuscripts devoted to the propaganda of self-torture and self-abasement, and the glorification of Nature-insulting fanatics. Art worshiped at the same shrine. Painters exhausted their fancy in the representation of physical wrecks and ghastly tortures. Winckelmann estimates that hardly one in ten thousand of the plastic masterpieces of a Nature-loving antiquity escaped the fury of the monastic iconoclasts. The war

against Nature was carried into every branch of moral and mental education.

Such doctrines did not fail to bear their fruit. Ignorance gloried in her indifference to the vanities of worldly science. Cruelty moralized on the duty of stifling the appeals to the law of Nature. Despotism enforced the precepts of self-abasement and passive obedience. Indolence welcomed the dogma of renunciation. The suppressed love of natural science begat a chimera-brood of pseudo-sciences—astrology, necromancy, alchemy, demonology, exorcism, thaumaturgism. Monkery and the neglect of rational agriculture conspired to turn garden-lands into deserts and freemen into serfs. The suppression of free inquiry begat hypocrisy and a mental sloth never equaled in the darkest ages of pagan barbarism. Freedom, driven from the open land, took refuge behind walled castles, and soon learned to make might the measure of right. Feudalism was the result, rather than the cause, of social degeneration. All the better instincts of the human mind were either suppressed or perverted by the influence of a principle equally foreign to the philosophy of the pagan moralists and the ethics of the Semitic religions—so foreign, that the attempt to amalgamate its doctrines with the manful monotheism of the Hebrew lawgiver is the chief cause of those mysterious inconsistencies which have so often frustrated the zeal of its propagandists: a benevolent Allfather, who yet frightfully and eternally tortures a vast plurality of his children; a God-created earth, that must be renounced to avoid the wrath of its creator; a godlike body, fit only to be despised and mortified.

Yet that mystery was solved by the same key that unlocked the etymological riddles of the Aryan languages—the study of the Hindoo scriptures. As the Vedas elucidated the origin and development of the Indo-Germanic tongues, the sacred writings of Buddhism revealed the root-dogma that bore its logical fruit in self-torture and renunciation: the doctrine of the worthlessness of earthly existence, and the necessity of salvation by the suppression of all earthly desires. According to the gospel of Buddha Sakyamuni, not the abuse of life, but life itself, is an evil. All earthly blessings are curses in disguise. The beauty of earth is the snare of the *Maya*, a mirage luring its dupes from error to error toward grief and repentance. Only he who has lifted the veil of that delusion has entered the path of salvation. Total abstinence from the joys of life is the only cure for its ills, and the highest goal of the future is *Nirvana*—peace and absolute deliverance from the vexations of earthly desires.

In their progress from the banks of the Ganges to the shores of the Atlantic those doctrines underwent various mystifying modifications, and under the humanizing influence of pagan ethics *Asceticism* assumed a meaning akin to that of Stoicism—frugality, self-control, virtuous preference of manly to effeminate pleasures. But, in the lan-

guage of the East-Grecian anchorites, *Askesis* meant simply *endeavor*, and that endeavor was an effort to tear the human mind from the roots of its earthly sympathies. The doctrines which his successors veiled in mystery, the hermit of Nepaul proclaimed with stern directness: absolute abstinence from all pleasures whatever, complete suppression of all earthly instincts and desires. He who would hope to reach the goal of salvation must court sorrow and affliction as others woo the smiles of Fortune. He must avoid everything that could reconcile him to life and lure him back to the delusions of earthly pursuits. He must despise worldly knowledge, the great object of life being the suppression of our natural inclinations, and, if possible, of our natural thoughts and feelings. He must have no fixed habitation, and must *avoid sleeping twice under the same tree*, lest an undue affection for any earthly object should hinder his spirit in the progress of its emancipation from the vanities of life!

The question remains, How could delusions of that sort ever assume an epidemic form? Upon which germ in the instincts of the human mind could the gospel of renunciation ingraft its monstrous dogmas? There is a significant tradition that Buddha Sakyamuni entered upon his mission only after exhausting the pleasures of wealth and luxury. It is an equally suggestive circumstance that the chief success of that mission was attained among the most effete nations of the overpopulated East—the Chinese, the Siamese, and the soul-sick pariahs of the Indian Peninsula. The doctrines of Buddhism recommended themselves to the pessimistic bias of a worn-out generation; moribund Impotence pleased herself in the idea that her lot is preferable to that of the survivors. *Anti-naturalism is an appeal to the life-weary instincts of decrepitude.*

In the evening twilight of life Nature relaxes the bonds of vitality, in order to reconcile her children to the prospects of the coming change. The weariness of a toilsome day sweetens the rest even of a dreamless sleep. To the germ of that instinct the doctrine of renunciation applies its fomenting stimulus. *Quietism* is a precocious senility. It is the premature development of an instinct that should assert itself only as a concomitant of superannuation. Hence the antagonism its dogmas encountered in the homes of health, hence the opposition of pagan philosophy and the *latent protestantism* of all manly nations. Hence, its concomitance with disease and decrepitude, its popularity in the bond-house of Despotism, its revival in the world-renouncing zeal of caged criminals, worn-out sensualists, and superannuated coquettes. Hence, also, the unparalleled progress of mankind since the time when the sluice-gates of Asceticism were finally forced by the explosion of the Protestant Revolt. Like the floods of a dam-breaking river, the energies of the Caucasian race are rushing down the long-forsaken channels of their former activity, and in all essential respects the triumphs of our boasted civilization have but followed

the resumption of a work suspended when the workmen of antiquity were interrupted by the shadow of the great eclipse—the millennium of ascetic insanity.

The true significance of the *anti-cosmic* principle was first revealed by the analytical studies of Arthur Schopenhauer, whose conclusions were strikingly confirmed by the historical researches of Wassiljew, Barthélemy Saint-Hilaire, Beal, Rhys Davis, Huc, Burnouf, Kern, Lassen, and Oldenberg. Like the doctrine of evolution, his theory met at first with obstinate opposition, but, like the doctrine of evolution, it will prevail by solving many riddles.

THE PRINCIPLES OF DOMESTIC FIREPLACE CONSTRUCTION.*

By T. PRIDGIN TEALE, F. R. C. S.

IF there be a place in the kingdom in which a lecture on the subject selected for to-night could appropriately be given, surely it is the theatre in which we are assembled. Some of my hearers may be aware of the mutual fitness of subject and place. Many, perhaps, are not aware, as, indeed, was the case with myself three months ago, that the principles of fireplace construction which will be laid before you to-night, and which I have been working out and teaching for the last three or four years, were urged, written about, and acted upon at the end of the last century by your founder, Count Rumford, and that a great portion of his time, his writings, and his work was devoted to this very question.

Hardly any subject would be more in harmony with the aims which he set before him in founding this society, as we may learn from the following quotation from the "Prospectus of the Royal Institution," published at the end of the fifth volume of Rumford's works: "But if it should be proved, as in fact it may, that in the applications of fire, in the management of heat, and in the production of light, we do not derive half the advantage from combustion which might be obtained, it will readily be admitted that these subjects must constitute a very important part of the useful information to be conveyed in the public lectures of the Royal Institution."

And why should it be necessary, at the end of this nineteenth century, to give a lecture on "The principles of fireplace construction"? Why should such a title draw together an audience? Clearly from the fact that correct principles have been habitually, and, until the last few years, almost universally violated, and because the rules so ably worked out, so earnestly and forcibly advocated by Rumford,

* A lecture delivered at the Royal Institution of Great Britain, February 5, 1886.

have lain dormant, lingering here and there, chiefly in old-fashioned houses, and almost forgotten.

Again, why should a layman, whose profession lies outside that of the architect, the builder, and the manufacturer, take upon himself to teach principles that are to guide other professions than his own? Mainly for two reasons: one, that there are principles which a medical man may work out without reproach, as tending to contribute to the happiness, the comfort, and the health of mankind; the other, that when principles have to be insisted upon, and to be made a subject of public instruction, they can be urged with more effect by those who are hampered by no relations to any patents, and have no pecuniary interest in the success or failure of the application of the principles in question. On this point we have a good example in Count Rumford, who says in a note: "The public in general and particularly those tradesmen and manufacturers whom it may concern, are requested to observe that, as the author does not intend to take out any patent for any invention of his which may be of public utility, all persons are at full liberty to imitate them, and vend them for their own emolument, when, and where, and in any way they may think proper."

Three evils result from the prevalence of bad principles in construction: 1. Waste of fuel and loss of heat. 2. Excessive production of soot and smoke. 3. Large addition to ash-pit refuse by cinders, which are really unburned, and therefore wasted fuel. These are matters of national concern, and it has been the main object of my labors on this question during the last four years to endeavor to convince the public that it is the interest no less than the duty of every householder to burn his fuel on correct principles, and to do his part toward the diminution of these evils.

On the first point, "waste of fuel and heat," let us listen to Rumford, whose words are as true to-day as when written eighty years ago: "Though it is generally acknowledged that there is a great waste of fuel in all countries, arising from ignorance and carelessness in the management of fire, yet few—very few, I believe—are aware of the real amount of this waste. . . . From the result of all my inquiries upon this subject, I have been led to conclude that not less than *seven eighths* of the heat generated, or which *with proper management might be generated*, from the fuel actually consumed, is carried up into the atmosphere with the smoke, and totally lost. . . . And with regard to the economy of fuel, it has this in particular to recommend it, that whatever is saved by an individual is at the same time a positive saving to the whole community."

Heat is wasted in three ways—either by combustion under the impulse of strong draught, which means rapid escape of heat up the chimney; or by imperfect combustion of the gases which are generated during the burning of the coals; or by escape of heat through the iron sides and back into the space between the range and the

brickwork, and so into the chimney. The greatest offenders are the ordinary register grates. Iron all over, back, and sides, and roof, they are usually set in a chamber open above to the chimney, and imperfectly filled in, or not filled in at all, with brickwork. The heat escapes through the iron to this chamber, and thence is lost. Another fault is that the "register-opening," in other words the "throat of the chimney," being immediately above the coal, submits the burning fuel to the full concentrated force of the current to the chimney, converting the fire into a miniature blast-furnace. On this point Rumford says: "But there are, I am told, persons in this country who are so fond of seeing what is called a great roaring fire, that even with its attendant inconveniences, of roasting and freezing opposite sides of the body at the same time, they prefer it to the genial and equable warmth which a smaller fire, properly managed, may be made to produce, even in an open-chimney fireplace."

The second result of faulty construction in fireplaces is "undue production of smoke and soot." Smoke and soot imply imperfect combustion, and to this two defects in a fire mainly contribute, one, too rapid a draught through the fire which hurries away and chills below burning-point the gas rising from the heated fuel. The other defect is too cold a fire, i. e., too small a body of heat in and around the fuel, so that the temperature of the gases is not raised to a point at which they will burn. On the smoke question Rumford waxes eloquent: "The enormous waste of fuel in London may be estimated by the vast dark cloud which continually hangs over this great metropolis, and frequently overshadows the whole country, far and wide; for this dense cloud is certainly composed almost entirely of *unconsumed coal*, which, having stolen wings from the innumerable fires of this great city, has escaped by the chimneys, and continues to sail about in the air till, having lost the heat which gave it volatility, it falls in a dry shower of extremely fine black dust to the ground, obscuring the atmosphere in its descent, and frequently changing the brightest day into more than Egyptian darkness."

A few years ago the prevalence of unusually dense fogs roused the metropolitan public to a sense of this great evil. The Smoke Abatement Society was formed, and under its auspices exhibitions of smoke-consuming apparatus and improved fireplaces were held in London and Manchester. Beyond the fact that certain grates were pronounced to be good in point of economy, and moderate in the production of smoke, and that the public has been led to take an interest in and inquire into the relative value and economy of various patent fireplaces, there has been but little advance in the education of the public in the principles which lie at the root of the whole question.

A third result of bad construction is the "production of cinders." With good coal, cinders are inexcusable. They are unconsumed carbon—coke—and imply a faulty fireplace. If thrown into the ash-pit,

as is the case in ninety-nine times out of a hundred, they are shameful waste, and more than waste, for they entail a great cost for their removal. The town of Leeds pays about fourteen thousand pounds a year for the scavenging of the streets and the emptying of ash-pits. Nearly every house in Leeds supplies in the way of cinders at least twice as much ash-pit refuse as it might do, were the fireplaces properly constructed. The ash-pit refuse of Leeds is burned in a "destructor," and the cinders in the refuse provide not only heat enough for its reduction to a mineral residue, but spare heat for driving two sixty-horse-power engines, and for consuming a reasonable amount of pigs, etc., killed by or on account of disease.

These three great evils, evils affecting not only individuals, but the community, waste of fuel and heat, production of soot, production of cinders, are a direct result of the violation of the correct principles in fireplace construction.

Let us next inquire what are the principles which promote good combustion in an open fireplace—i. e., what are the conditions which are essential to enable fuel to give out to a room "good money's worth in heat." That such a result may be obtained, fuel must burn *well* but *not rapidly*. Two things in combination are essential to the combustion of fuel—a supply of oxygen, and a high temperature—i. e., plenty of heat around the fuel. If fuel be burned with a hot jacket around it, a very moderate amount of oxygen will sustain combustion, and, if the supply of oxygen be moderate, combustion is slow. Burn coal with a chilling jacket around it, a rapid conductor like iron, and it needs a fierce draught of oxygen to sustain combustion, and this means rapid escape of actual heat, and also of potential heat in unburned gases and smoke, up the chimney. This is the key to the whole position ; this is the touchstone by which to test the principles of fireplace construction.

Few people probably realize the exact conditions of combustion, which may be well illustrated from the process of manufacture of coal-gas. In coal we have three kinds of constituents : One mineral, incombustible, seen in the ash residue, which for good coal amounts to barely three per cent. The second, volatile, and which, under the influence of heat becoming gaseous, appears in an open fire as tall flame and smoke, and, where combustion is imperfect, produces soot. The third constituent is carbon or charcoal, familiarly known as coke or cinder, and when burning gives a short, shallow, bluish flame. The carbon and the volatile portions can be raised to a high temperature, and still will not burn unless oxygen be brought into contact with them.

In the manufacture of gas, coal is raised to a high temperature, and the gases are driven off by roasting the coal in an oven from which air, i. e., oxygen, is shut out. The gases are conducted away, cooled, purified, and stored for future use in a gasometer ; the com-

bined carbon and mineral residue, being non-volatile, is cooled down before being exposed to the air, and is sold as coke. Here we have a striking proof of the fact that high temperature in fuel does not of itself involve combustion. If air were admitted to the red-hot coke, or to the gases as they escape in their heated condition from the furnace, they would burn. But when coke has become cold, and the gases are cold, as in a gasometer, no amount of oxygen will of itself start combustion.

The deduction from all this is, that complete oxidation, i. e., good combustion, is possible only when the fuel and gases are at a high temperature, and that high temperature of fuel does not produce combustion until oxygen is introduced: therefore we can have a high temperature of fuel, without rapid combustion, provided we control and limit the supply of oxygen. If we have thoroughly grasped these elementary facts, we shall be in a position to understand the points to be aimed at in the construction of a fireplace.

My attention was first directed to the question of waste of fuel at the time of the coal-famine some twelve years ago. I read in the "Times," and acted upon the suggestion, to economize coal by inserting an iron plate on the grid under the fuel so as to cut off all draught through the fire. This undoubtedly induced slow combustion, and economized fuel, but the fire was dull, cold, and ineffective. The plan was abandoned. It taught me, however, the fact that combustion could be controlled by cutting off the under-draught, but I did not then see why combustion was spoiled. The reason was that the under surface of the fire was chilled, and the fuel lost its incandescence owing to the rapid loss of heat through the iron toward the open-hearth chamber. To some persons even now "slow-combustion stoves" are an abomination, and are supposed to by synonymous with bad combustion.

The next stage in my fireplace education was the adoption of the Abbotsford grate. I thereby learned that the reason why an Abbotsford grate was an advance upon the iron plate lay in the fact that the solid fire-brick bottom stored up heat and enabled the fuel to burn more brightly resting upon a hot surface—not upon a cooling iron plate. But Abbotsford grates, and the other class of grates with solid fire-brick bottoms, the Parson's grates, have disadvantages. They are apt to become dull and untidy toward the end of the day, and do not burn satisfactorily with inferior coal. There is a better thing than a solid fire-brick bottom, and that is the chamber under the fire closed in front by an "Economizer."

The history of the next, the most important stage of my fireplace education, was as follows:

Some five years ago I made, somewhat accidentally, the discovery that the burning of coal in an ordinary fireplace could be controlled and retarded by the adoption of a very simple and inexpensive con-

trivance, applicable to nearly every existing grate, and that this result could be attained without impairment of, and often with increase of, the heating power of the fire. This contrivance, which I have named an "Economizer," was simply a shield of iron, standing on the hearth, and rising as high as the level of the grid at the bottom of the grate, converting the hearth-space under the fire into a chamber closed by a movable door.

The effect was twofold: The stream of air, which usually rushes through the bottom of the fire, and causes for a short time rapid combustion at a white heat, was thereby cut off, and the air *under the fire* was kept stagnant, the heated coal being dependent for its combustion on the air passing *over the front and the upper surface.* The second point was that this boxing up rendered the chamber hotter, and this increased temperature beneath the fire-grate, i. e., under the fuel, added so materially to the temperature of the whole, even of the cinders coming into contact with the iron grid, that the very moderate supply of oxygen reaching the front and upper surface of the fuel was sufficient to maintain every portion in a state of incandescence. Moreover, I observed that combustion was going on at an *orange*, not at a *white*, heat.

Let us contrast a white with the orange heat. A *white heat* in a fire means *rapid combustion, owing to the strong current of air, oxygen, which passes under the grate, through the center of the fire*, and up the chimney. As soon as the heart of the fire has been rapidly burned away at a white heat, the fuel cools; the iron grid cools also; and the cinders in contact with the grid are chilled below combustion point. They then cease to burn, and the bottom of the fire becomes dead and choked. The poker must now be brought into play to clear away the dead cinders, and to reopen the slits in the choked grid. New coal is added to the feeble remnant of burning embers, with no reserve of heat in the iron surroundings; and in time, and perhaps very slowly, the fire revives, and rapid combustion sets in afresh under the influence of the renewed current of oxygen passing through the heart of the fire. An *orange heat* means that the coke, i. e., the red-hot cinder, is burning with a *slowly applied stream of oxygen, a degree of combustion which is only possible when the coal is kept warm by the hot chamber beneath*, and by a reasonable limitation of loss of heat at the back and sides by fire-brick, either in contact with the fuel, or at least close behind the iron surrounding it. This effect is seen, partially, in the grates with solid fire-brick bottom, but far more perfectly in the grates with the chamber closed by the "Economizer."

This hot chamber has the following effects: The incandescent coal remains red-hot from end to end of the grate, until nearly all is consumed, thus maintaining a larger body of the fuel in a state to radiate effective heat into a room. The cinders on coming into contact with the iron grid also remain red-hot, and so continue to burn

away until they fall through the grid as a fine powder. This allows the fire to burn clearly all day long almost without poking. When the fire is low, and new coal is added, the reserve of heat in the hot chamber is such that the addition of cold fresh fuel does not temporarily quench the embers, and the fire is very quickly in a blaze after being mended.

Having made the discovery by the observation of a grate supplied to me with an "Economizer," the value of which, I suspect, was hardly appreciated by the makers, I applied "Economizers" one by one to all my grates, kitchen included. The result surpassed my expectations. There was a saving of at least a fourth of my coal. The experience of many friends, who, at my advice, adopted the system, confirmed my own results. It was, therefore, clear to me that I was bound to make widely known a discovery which was fraught with such benefit to myself, and was likely to prove a great boon to the public.

My chief aim hitherto has been to persuade the public to apply the "Economizer" to existing fireplaces. After steady exertions for four years, some impression has been made on the inertia of the public, and extensive trials of the "Economizer" are taking place in many parts of the country. To-day, however, my aims are more complete. It is my wish to advocate not one principle alone, although that is the cardinal one, but to urge all the best principles which enter into the construction of a really effective fireplace, and to induce those whom it may concern to replace bad by an entirely new construction, right in every point.

The rules of construction which I shall lay down have been arrived at entirely by my own observation of what appeared to be the best points in various fireplaces. It was, therefore, no less a satisfaction to me than a surprise to discover, on reading Rumford's work in preparation for this lecture, that nothing which I have to advocate is new, but that every principle, and the "Economizer" is hardly an exception, was advocated no less enthusiastically by him at the very commencement of this century.

Having considered the principles that should guide us, we are now prepared to lay down strict rules which should be acted upon in the construction of fireplaces. I trust that what I have said has so far commended itself to your judgment that the fourteen rules here drawn up will command your hearty assent, and in due time will win their way into the confidence of our architects, our builders, and the public:

Rule I. "*As little iron as possible.*"—The only parts of a fireplace that are necessarily made of iron are the grid on which the coal rests, and the bars in front. The "Economizer," though usually made of iron, from convenience in construction, might be of earthenware, and so would be more perfectly in harmony with this rule. On this point Rumford speaks most emphatically: "Those (grates) whose

construction is the most simple, and which, of course, are the cheapest, are beyond comparison the best, *on all accounts.* Nothing being wanted in these chimneys but merely a grate for containing coals, and additional apparatus being not only useless but very pernicious, all complicated and expensive grates should be laid aside, and such as are simple substituted in their stead. In the choice of a grate, beauty and elegance may easily be united with perfect simplicity. Indeed, they are incompatible with everything else." Again he says, "Iron, and in general metals of all kinds, are to be reckoned among the very worst materials that it is possible to employ in the construction of a fireplace."

RULE II. "*The back and sides of the fireplace should be of brick, or fire-brick.*"—Brick retains, stores, and accumulates heat, and radiates it back into the room, and keeps the fuel hot. Iron lets heat slip through it up the chimney, gives very little back to the room, and chills the fuel. On this point also Rumford speaks very strongly. "The best materials I have hitherto been able to discover are fire-brick and common bricks and mortar. . . . The fuel, instead of being employed to heat the room *directly* or by the direct rays from the fire, should be so disposed or placed as *to heat the back and sides of the grate*, which must always be constructed of fire-brick or fire-stone, and *never of iron or any other metal.*"

RULE III. "*The fire-brick back should lean over the fire, not lean away from it,*" as has been the favorite construction throughout the kingdom. The lean-over not only increases the power of absorbing heat from rising flame—otherwise lost up the chimney—but the increased temperature accumulated in the fire-brick raises the temperature of gases to combustion-point, which would otherwise pass up the chimney unconsumed, and thus be lost. Rumford discovered accidentally the value of this "lean-over," and at once realized its immense importance. He does not, however, seem to have carried out his intention of working out for general adoption this form of back.

He first of all condemns to alteration all fire-backs which lean away from the fire. "It frequently happens that the iron backs of grates are not vertical, but inclined backward. Where the grates are wide, and can be filled up with fire-brick, the inclination of the back will be of little consequence, since, by making the fire-brick in the form of a wedge, the front may be made perfectly vertical, the iron back being hid in the solid work of the fireplace. If the grate be too shallow to admit of any diminution, it will be best to take away the iron back entirely, and cause the vertical back of the fireplace to serve as the back to the grate."

He next describes his discovery of the value of the "lean-over": "In this case I should increase the depth of the fireplace at the hearth to twelve or thirteen inches, and should build the back perpendicular to the height of the top of the burning fuel, and then, sloping the back

by a gentle inclination forward, bring it to its proper place, that is to say, *perpendicularly under the back part of the throat of the chimney.* This slope (which will bring the back forward four or five inches, or just as much as the depth of the fireplace is increased), though it ought not to be too abrupt, yet it ought to be quite finished at the height of eight or ten inches above the fire, otherwise it may perhaps cause the chimney to smoke.

"Having been obliged to carry backward the fireplace in the manner here described, in order to accommodate it to a chimney whose walls in front were remarkably thin, I was surprised to find, upon lighting the fire, that it appeared to give out more heat into the room than any fireplace I had ever constructed. This effect was quite unexpected; but the cause of it was too obvious not to be immediately discovered. The flame rising from the fire broke against the part of the back which sloped forward over the fire, and this part of the back being soon very much heated, and in consequence of its being very hot (and when the fire burned bright it was frequently quite red-hot), it threw off into the room a great deal of radiant heat. It is not possible that this oblique surface (the slope of the back of the fireplace) could have been heated red-hot *merely* by the radiant heat projected by the burning fuel; for other parts of the fireplace nearer the fire, and better situated for receiving radiant heat, were never found to be so much heated; and hence it appears that the combined heat in the current of smoke and hot vapor which rises from an open fire *may be*, at least *in part*, stopped in its passage up the chimney, changed into radiant heat, and afterward thrown into the room.

"This opens a new and very interesting field for experiment, and bids fair to lead to important improvements in the construction of fireplaces. . . . But, as I mean soon to publish a particular account of these fireplaces, with drawings and ample directions for constructing them, I will not enlarge further on the subject in this place. It may, however, not be amiss just to mention here that these new invented fireplaces not being fixed to the walls of the chimney, but merely set down upon the hearth, may be used in any open chimney; and the chimneys altered or constructed on the principles here recommended are particularly well adapted for receiving them."

Of recent years "lean-over" backs have been reinvented and sparingly used. The "Milner" back is excellent. It burns fuel well, and gives out a great heat. But it is extravagant in consumption, unless controlled by the "Economizer."

Captain Douglas Galton saw the virtue of the "lean-over," and adopted it in the grate which goes by his name. The "Bee-hive" back was the same in principle and very good, and, having a very small grid, was economical.

The "Rifle" back gives an admirable fire, little short of perfection; but observation shows that the "tall" flame extends far beyond

the bend, and is therefore soon lost as a heating factor, the heat being wasted in the chimney.

From the commencement of my study of the fireplace question the value of the "lean-over" has not only taken firm hold of my fancy, but my sense of its importance has been growing in intensity, until I saw that the best construction must show the greatest possible extent of "lean-over" that could be obtained without sacrifice of other important details of construction. How to accomplish this will appear in considering the fifth rule.

RULE IV. "*The bottom of the fire, or grating, should be deep from before backward, probably not less than nine inches for a small room, nor more than eleven inches for a large room.*" This is a corollary to Rule III. We can not possibly have the back of the fireplace overhanging the fire when there is a shallow grid. If for no other reason than the demands of the "lean-over," depth of fire-space is essential. But there is gain, thereby, in another direction. It affords plenty of room for the burning fuel to lie down close to the grid, and away from swift air-currents, and prevents the tendency of the fire to burn hollow.

On this point Rumford has a word to say: "But as many of the grates now in common use will be found too large when the fireplaces are altered and improved, it will be necessary to diminish their capacities by filling up with pieces of fire-brick. But, in diminishing the capacities of grates, care must be taken not to make them *too narrow*, i. e., too shallow.

"The proper depth for grates for rooms of middling size will be from six to eight inches. But, where the width (i. e., depth) is not more than five inches, it will be very difficult to prevent the fire going out."

"Where grates designed for rooms of middling size are longer (and broader) than fourteen or fifteen inches, it will always be best to diminish their length by filling them up at their two ends by fire-brick."

RULE V. "*The sides or 'covings' of the fireplace should be inclined to one another as the sides of an equilateral triangle*" (Fig. 2). The working out of this rule has cost me much thought and experiment. It was worked out more or less empirically with a view to attain certain objects, and, having attained them, I discovered that I had unwittingly selected the sides of an equilateral triangle. It is of some importance, and may be of interest, to tell how the question arose. In my earlier fireplaces the sides or "covings" were parallel to each other, and had the defect that they radiated most of their heat from one to the other, not into the room, with the probable result that much of such heat would eventually escape up the chimney.

It was clear, then, that the sides must be set at an angle with the back, so as to face toward the room. But at what angle? My first

experiments were determined by the shape of the corner bricks which were in the market. These determined the inclination of the sides to be such that, if prolonged, they would meet at a right angle. This is the angle laid down by Rumford as the angle of selection, but as the largest angle admissible in a good fireplace. This angle, however, brought me into difficulties with my "lean-over" back. The openness of the angle made the back, as it ascended, spread out so rapidly that what was gained in width was lost in height. Moreover, my critics objected to its appearance as ugly. What, then, should determine the inclination of the sides? The point was thus determined: Seeing that a heated brick throws off the greatest amount of radiant heat at a right angle with its surface, the "covings" should be at such an inclination to each other that the perpendicular line from the inner margin of one "coving" should just miss the outer margin of the opposite "coving." Where the "covings," as in my earlier attempts and in Count Rumford's fireplaces, are at a right angle to each other, this perpendicular line misses the opposite margin by several inches. It was clear, therefore, that the inclination might be made more acute. Guided by this idea, and having determined the principle on which the shape of the grate should depend, an inclination was arrived at which turned out to be an angle of 60°, i. e., the inclination of the sides of an equilateral triangle.

Count Rumford came very nearly to the same conclusions: "I have said, in my essay on chimney fireplaces, that where chimneys are well constructed and well situated, and have never been apt to smoke, in altering them the 'covings' may be placed at an angle of 135° with the back; but I have expressly said that they should never exceed that angle, and have stated at large the bad consequences that must follow from making the opening of a fireplace very wide, when its depth is very shallow."

Rule VII. "*The 'lean-over' at the back should be at an angle of 70°*" (Fig. 1).—Commencing at a level (A) corresponding with the top of the front bars, and leaning forward at an angle of 70° with the horizontal line of the hearth, the back should rise to such a point that the angle where it returns toward the chimney (B) should be vertically over the insertion (C) of the cheeks of the fire-grate. This angle (B) will be about twenty-eight inches from the hearth, or sixteen inches from the top of the fire, and about three and a half to four and a half inches from the front line of the fireplace, according to the size of the grate. These points will be obvious from the vertical section of the fireplace here shown, and from C, Fig. 2.

So far, in the fireplaces built after my rules, the height of the grid from the hearth has been taken at two bricks, or six inches, and the height of the bars from the grid also at two bricks, or six inches. It follows, therefore, that the lean-over commences at twelve inches from the hearth. It is possible that a better angle than 70° may eventually

be found—such as an angle of 60°—but commencing a few inches above the fire so as *not to lower the angle* B where the lean-over returns to the chimney.

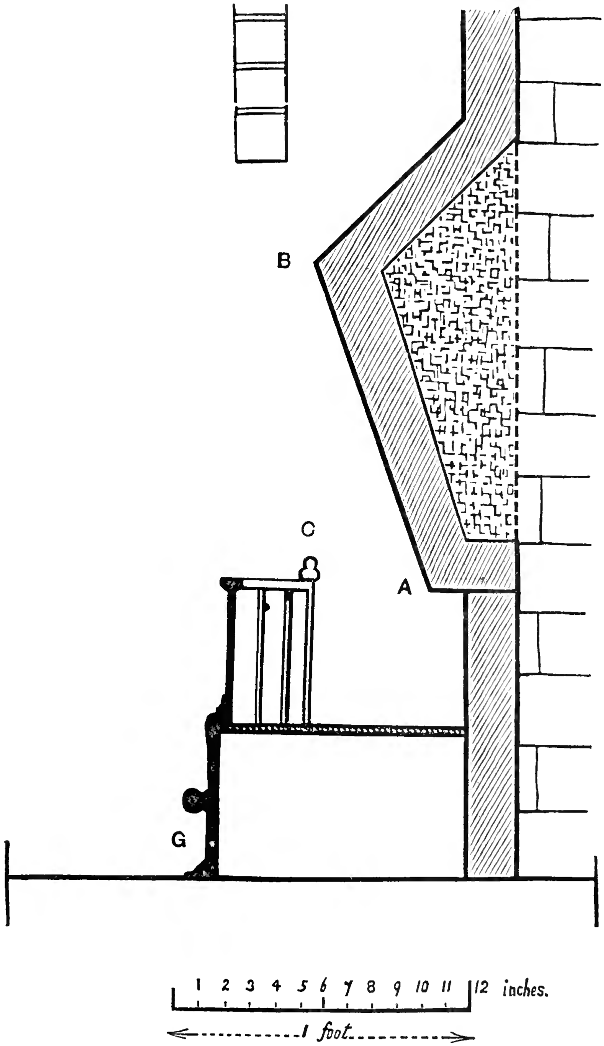


FIG. 1.

RULE VIII. "*The shape of the grate should be based upon a square described within an equilateral triangle, the size to vary in constant proportion to the side of the square*" (Fig. 2).—The shape of the grate, or grid, is arrived at in the following way: Describe a square, D, of which the sides shall be eight, nine, or ten inches, according to the size of the room, within an equilateral triangle, E, the two sides of which

shall represent the "covings" of the fireplace, and the base the front line of the fireplace. From each front angle of the square carry a line from D to C, to the "covings" or sides of the triangle, at an angle of 45° with the front line of the fireplace. These two lines, with the side of the square from which they are drawn, form the front of the grid. The back line of the grid does not correspond with the corresponding side of the square, but is carried one and a half inch farther back, so as to give greater depth to the grate, and allow the fire-brick back to overhang the back of the grid to the extent of one and a half inch (see A, Fig. 1) before it ascends as the "lean-over."

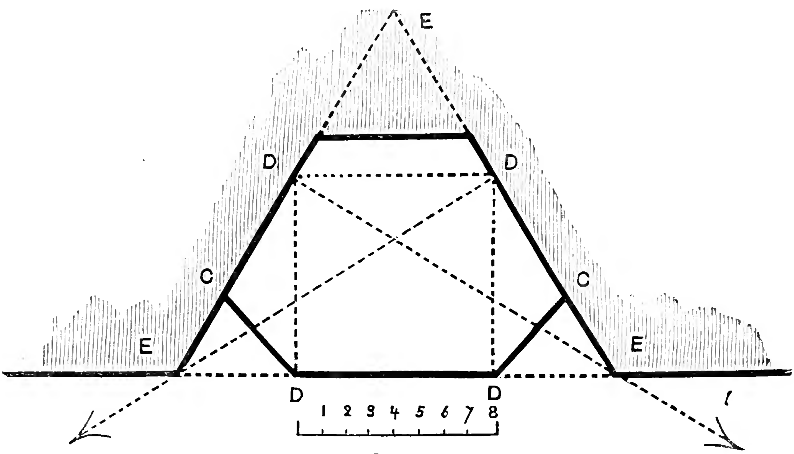


FIG. 2.

The diagram of the grate, with the square and triangle on which it is based in dotted lines, will, I hope, make this description sufficiently intelligible. Whenever a grate on this principle proves too hot for a room, and in summer when a smaller fire is needed, the size should be reduced *in width* by triangular fire-bricks at each side, which reduce the fire-space to a square, with the addition of the one-and-a-half-inch space under the back. This rule secures sufficient depth from front to back, and a constant proportion between depth and width, whatever be the size of grate.

RULE IX. "*The slits in the grating, or grid, should be narrow, perhaps one fourth inch for a sitting-room grate and good coal, three eighths for a kitchen-grate and bad coal.*"—When the slits are larger, small cinders fall through and are wasted.

RULE X. "*The front bars should be* vertical, *that ashes may not lodge and look untidy;* narrow, *perhaps one fourth inch in thickness, so as not to obstruct heat; and* close together, *perhaps three fourths of an inch apart, so as to prevent coal and cinder from falling on the hearth*" (Fig. 3).—It is too soon to judge as to the lasting powers of one-fourth inch bars. Those in one of my own grates are round, and,

after four and a half months' daily wear, show no sign of burning away. Flat bars, one fourth inch by one half inch, or even by two thirds of an inch, might perhaps resist fire better, if the one-fourth-inch round bars burn away. The bars are so arranged that, if one fails, it can easily be renewed. I have round bars about one third of an inch in diameter at present on trial in my kitchen-range.

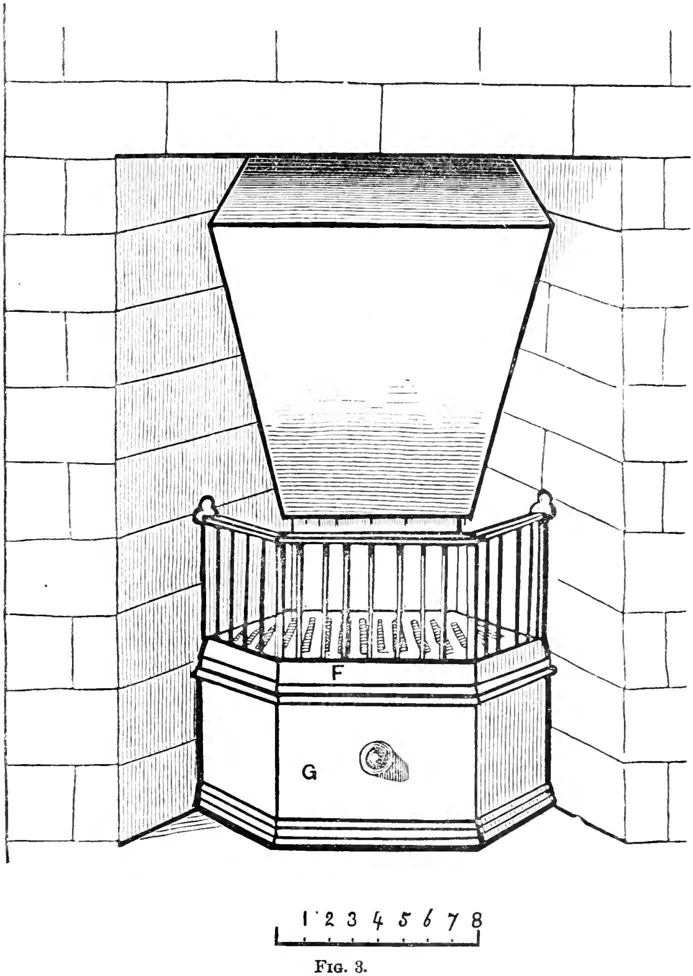


Fig. 3.

Rule XI. "*There should be a rim one inch or one and a half inch in depth round the lower insertion of the vertical bars*" (Fig. 3).—The object of this is to conceal the ash at the bottom of the fire, and to enable the front cinders to burn away completely by protecting them from the cold air. This rim (F) contributes greatly to tidiness, and as a rule will prevent the need of any sweeping up of the hearth during the day.

Rule XII. "*The chamber under the fire should be closed by a shield or economizer*'" (G, Figs. 1 and 3).—This has been already spoken of, and described as the central principle which enhances greatly the value of all the rest.

Rule XIII. "*Whenever a fireplace is constructed on these principles, it must be borne in mind that a greater body of heat is accumulated about the hearth than in ordinary fireplaces. If there be the least doubt whether wooden beams may possibly run under the hearth-stone, then an ash-pan should be added, with a double bottom, the space between the two plates being filled with artificial asbestus, 'slag-wool,' two inches in thickness.*"

Rule XIV. "*A fireplace on this construction must not be put up in a party wall, where there is no projecting chimney-breast, lest the heated back should endanger woodwork in a room at the other side.*"

Having now worked up rules for the construction of an effective fireplace, let us consider what benefits result.

1. *Economy of Fuel.*—I have already stated that my own experience of the application of the "Economizer" to all my original fireplaces, including kitchen and scullery, was a saving of more than one fourth. Friends who have followed my advice report variously from a sixth to one third. The saving in the Leeds Infirmary, according to returns supplied to me by Mr. Blair, the general manager, has been nearly a sixth, amounting to nearly one hundred tons in the year. What the saving in the fireplaces constructed on the best rules may be I can not say, probably about the same degree of saving, with a large increase of heat given into the room. My conviction is that such fireplaces make one ton of coal give out as much heat into a room as two tons would yield if burned in the worst forms of the nearly obsolete register-stove.

2. *Reduction of Soot.*—This is, perhaps, from a national point of view, the most important point in connection with our subject—and yet it is the portion of it in which my evidence is the most defective. I can only offer you my general impression that there is a very important reduction in the amount of soot, an impression based upon observation of the smoke issuing from chimneys where "Economizers" are in use, and of the diminution of soot falling about my own house, which is confirmed by the testimony of Miss Gordon, Lady Superintendent of the Leeds Infirmary, as to the lessened amount of soot which finds its way into the wards.

3. *Reduction of Ash-pit Refuse.*—This point is clearly proved by the fine, snuff-like powder, free from cinders, which I show; and by the fact that the whole produce in the ash-pit of my kitchen fireplace for one week was contained in one ash-pan, and weighed fifteen pounds.

Danger of Fire.—Seeing that improved fireplace construction involves increased heat about the hearth, an actual danger of fire will

be created where the hearthstone rests on wood, unless the hearth itself be protected. It was therefore my duty to find out a means of protecting the hearth. With this view, experiments have been made with ash-pans with double bottoms and a small air-space between the ash-pan and the hearth. The results are shown in the specimens of cotton-wool, wood, etc., which have been exposed under ash-pans of various constructions. My conclusion is that two inches of artificial asbestus at the bottom of an ash-pan would render any hearth safe. Such an ash-pan may be named a "Hearth-Protector." Another caution should be given against erecting one of these improved fireplaces where there is no projecting chimney-breast, lest there should be insufficient depth of brick between the back of the fire and the woodwork of a room at the other side.

"*Kitchen Refuse.*"—In some households there are certain portions of kitchen refuse which are apt to find their way into the dust-bin, instead of the pig-tub. You here see the remains of refuse, consisting of celery-stalks, potato-parings, etc., which have been roasted in a wire cage underneath my kitchen-fire in the chamber closed by the "Economizer." The wire cage is necessary to allow the heat to reach the under surface of the refuse.

Having now for four years done my best to persuade the public to take measures in reference to fireplaces which will confer upon them a saving in the cost of fuel, a saving in the labor of servants, an increase in the warmth and comfort of rooms, a lessening of the soot in the atmosphere of towns, and a possibility of reduction of scavenging rates, it is no little satisfaction to feel that my views are at last making way, and acquiring a momentum of their own.

It only remains for me now to bring my address to a conclusion with the words of the Roman poet—

"*Non fumum ex fulgore, sed ex fumo dare lucem.*"
HOR., ARS. POET.

—which I will translate in the words of one of our greatest Latin scholars, the late Professor Conington :

"Not smoke from fire my object is to bring,
But fire from smoke, a very different thing."

SCRATCHING IN THE ANIMAL KINGDOM.

BY PROFESSOR SAMUEL LOCKWOOD.

FOR nearly two weeks, one midwinter, my studies were pleasantly interrupted by a nightly visit of that funny arachnidan, *Phalangium dorsatum*, Say. We often hear it called Daddy-long-legs, which name in England is given only to the long-legged dipteran, the *Tipula*, or crane-fly. My visitor's domicile was a nook somewhere in the

library. As appearances are often deceptive, it would not be safe to predicate a literary taste of my bookish visitor, but the creature's measured gait and pedal sprawl over my written page did suggest the airs of a stilted critic. And yet, to use a trade-phrase, with all its seeming bigness, phalangium did not "size up much." Its egg-shaped body was exactly a quarter of an inch in length, and an eighth wide at its thickest part. Of its eight legs, each one in the shortest pair measured an inch and five eighths, and in the longest pair the measurement exceeded three inches, a considerable spread for so little timber. There was quite a good understanding between us. It would allow me to touch the long, thread-like legs with my pen, and even to lift one up above the others, and the queer thing would keep the limb raised for several minutes, precisely as I would leave it, as if it were hypnotized.

The phalangium is a member of a tribe of the spiders known as the *Pedipalpi*, because the palps or feelers end, like the feet of many insects, in a claw, sometimes a pair, thus making a forceps. After my tickling his perambulators, Daddy seemed to have got his ideas started, for, having adjusted his octapodal highness upon my manuscript in most admirable equipoise, he began the delectable exercise of scratching his legs. I am sure that the operation was enjoyable to him, while to me the sight was very interesting. If Captain Cuttle should find it necessary to try the flexibility of a whip-stock, it is supposable that he would take the handle in his left hand, and with a pressing motion pass the whip for its entire length through the iron hook which served for his right hand. The whip would thus take on a loop-like curve, and would straighten itself out with somewhat of a snap. Just in this way did my spider scratch his slender legs—for one at a time were these long elastic limbs passed through the hook of the palp, when the limb would be bent like a loop or bow in the process, and as it left the hook or claw by its elasticity would do so with an almost whip-like snap.

The higher one ascends the animal scale in such observations, the more pronounced is found this habit of scratching the skin-surface of the body. Individually, Maud S. and Coomassie may be "too high-toned" for such a practice. But these creatures are coddled out of conscience by the groom, who has the comb and the brush almost always on their pelts; hence, if these "high-bloods" come not to the scratch, it is because the scratch comes to them. Cushie and Dray, put upon their own resources, enjoy hugely a good rubbing self-administered against a tree or post.

Happening one day in my lady's boudoir, I picked from the cabinet what I took for a pretty bit of *bric-à-brac*. It was an ebony stem, about fourteen inches long, not thicker than one's finger, and quite daintily turned. At one end was attached a pretty little hand deftly wrought in ivory. It could not be called a fist, for I noticed that the fingers were only half closed. The nails were well developed, and

their ends or edges were set in a line. This artistic trifle seemed to me made for some special purpose. A whisper from a friend enlightened my wonderment—"A back-scratch." I caught at once. Now, I have read of a toy formerly common in England, which at fairs or upon occasions of a crowd, would be passed over the back of a rustic, when it made a noise like the tearing of cloth, and suggestive of a rent behind, to the poor man's dismay. This, too, was called a "back-scratch." But that was simply the vehicle of a bit of mischief. My lady's back-scratch was for use in that very much out-of-the-way place between the shoulder-blades. This handy implement, though an article of *virtu*, was in the line of luxury, although the amenities would hardly approve the indulgence before eyes polite.

The above reminds how gingerly and faulty the treatment of the word is by the lexicographers. One would think it only meant to abrade, lacerate, excoriate, whereas how common the usage by which it signifies to titillate with mild friction! The Latin expresses the action nicely, *scabere cutem leviter ungue*, which in good English is simply—to rub the skin lightly with one's nails. Pliny has *aures pedibus*, scratching the ears with the feet, which suggests the experience of that tourist in Italy who rode a mangy mare. The beast had a bad habit of stopping to scratch her ears, and, the hind-feet being used for that purpose, the thighs of the rider received all the benefit of the operation, which, like tickling with a brickbat, was too crude for real comfort. But the ungulates generally are bunglers at this trick, though not insensible to opportunity, as witness when our neighbor's cow got into the lawn, and, wild with delight, went tearing through the soft evergreens, our pretty arbor-vitæ trees, which was so much nicer than rubbing against a fence.

It behooves to confess that Nature has been a niggard in this matter unto man, having done less for him in this line than she has for the beasts that perish. "The paragon of animals" is the victim of irritation from eczema in a hundred forms and degrees. Though having already thrown a stone at the lexicographers, here goes another, for we must cite from memory that churlish dictionary-maker, Dr. Johnson, who wrote in the first edition of his dictionary, "Oat—a grain used in England to feed horses; in Scotland, men." This was very unbecoming. But the food has much to do with the condition of the cuticle. Hence we put together the Scotsman's "oaten cakes" and the legend of the benevolent nobleman who set up scratching-posts in the streets of Edinburgh, and the canny benediction of each user of them, "God bless the Duke of Argyll!"

On the physical or rather physiological side of the question, a good deal might be said for this mild friction of the skin. Near the surface—that is, just under the scarf, or epidermis—the capillaries, almost microscopic blood-veins, abound in well-nigh infinite numbers. Each of these minute carriers or distributors of the crimson life-

stream has along its sides its complement of nerves nearly parallel. Between these nerve-fibers lies the undifferentiated protoplasm, or life-stuff, which is the supply of constructive matter for the use of these tiny builders, for out of this life-matter, or bioplasm, each cell is built. But even mortar may need quickening—so this life-stuff may become too passive, that is, *quasi* torpid. These nervous fibrillæ are the electric wires, and gentle friction is the dynamo to generate the mysterious fluid and quicken the conductivity along the lines.

Strange to say, this scratching has also its psychological side. Let a puzzle be propounded, and why on the instant does the nonplused one institute a rummaging for an idea in the hirsute thatch of his cranium? And everybody does it, even he "of the front of Jove himself" more than the beetle-headed clown. We asked an explanation of our encyclopedic friend who "knows it all," and quoted to him the well-worn distich:

> "Be mindful, when invention fails,
> To scratch your head and bite your nails."

Upon the word he began disheveling his carefully brushed hair, saying it was "a poser," and, by way of compliment, that it "was not slow"; to which our response, "No, it's Swift"; at which he laughed, though he had quite missed the point, for he rejoined that he always thought us "a little fast."

It is truly wonderful how lavishly and admirably Nature has gifted many animals for this very exercise of scratching lightly with the claws. At my feet lie Tom and Dick, two good friends. The former is a fine young Maltese, the latter an old black-and-tan. The cat's claws are very sharp, the dog's are less so. Both animals are clean and in good condition, yet both appear to take delight in a good scratching at the back of the head, and especially behind the ears. The hind-foot is the instrument used, and with what delicacy—yes, nicety, or precision of adjustment! So rapidly does that foot move, that it makes a fan-like shadow; and so exact the distance at which the keen, protruded claws are set, that it secures only a delicate touching of the parts, producing the pleasant titillation of the tonsorial brush. Any coarser adjustment of those needle-pointed hooks and the blood would flow from the lacerated skin.

But, even more than with the mammals, is this cuticular titillation a necessity with the ordinary fishes; and, since they have neither hands nor feet, how is this want in their case gratified? I have witnessed the operation many times, yet fear a failure to adequately describe it. The scaly coating of a fish needs an occasional cleaning, as does the copper sheathing of a ship; for, with both, a foul surface impedes progress through the water. On each side of a typical fish is a thin line, known as the lateral line. It is, in fact, a mucous canal, from which issues at the will of the animal a lubricating fluid, which, spread over its scaly sheathing, lessens friction, and so facilitates movement

in the water. This mucous line is made up of rows of pores, which communicate with the slime-secreting glands. Leydig discovered that each of these oil-producers had its own nerve, thus constituting a series of sense-organs. And very delicate is their sense, as by them the fish gauges the weight of the water-mass, also the direction and resistance of currents. But associated with these nerves arranged in tufts, or buttons, are air-cells, hence it seems certain that the fish is able to appreciate vibration in water, whose wave-lengths are larger than are those of sound. The faculty of appreciating the waves of light, we call seeing, and similarly of sound, hearing, whose waves are much larger than those of light. But our scaly subject is endowed with a third wave-measuring sense, in which possession it out-paragons "the paragon" himself. It can appreciate the trills or waves of water vibration, and of this faculty our language has no word to express the name.

Now, these oil-yielding tubes above described may get clogged, or the glands become torpid. Here, then, are sense-organs to declare the state of affairs. Hence arises the necessity for the animal either to clean off its body armor, or to stimulate into activity the indolent organs. And, in fact, in other ways, fishes have their own eczema, or diseases of the skin. Sometimes there is a blistering or deterioration of the cutis, and sometimes a species of *Saprolegnia*, a fungous parasite, sets up a floculent growth on the cuticle. For any of these instances friction is the only remedy, and its exercise is unquestionably pleasant to the fish.

But how can a fish scratch itself? Sometimes in the way of Cushie, as when she rushed through the evergreens. So a fish will often dart through a dense clump of soft water-weeds. But this amounts to little else than a gentle titillation. The scaly sheath is not to be cleansed so easily. I have seen the performance many times, and by several species, but none have so much interested me in this respect as the sunfish. Take the one best known to the pin-hook anglers, and often called "pumpkin-seed." There is a bowlder with a smooth, clean surface. The fish is steady; its big eyes seem of a sudden to glow with a blue light. Every fin is set, even to the dorsal, which bristles with its keen spines. The fish seems aiming for that stone. The propulsion must come from the caudal and the side fins, but mostly from the former. All these give a simultaneous blow against the water; at the same time, as if it were in the way, the top-sail—that is, the dorsal—falls and is snugly reefed. All this is done in a moment, and such the force that the fish truly darts, threatening to butt its nose against the rock. The speed is high, but, just ere the rock is reached, there is a marvelously sudden bend of the body, the most convex point being the exact spot which is to be scratched. Though very rapid, so well-timed is the movement, and so nice the adjustment of the position, that the pressure or amount of rub or friction is correctly received, and the

point of impact is precise, and the body glances from the rock. The collision is so accurately gauged that no harm is done. And similarly, and with a great variety of ingenious posturing, the fish subjects all parts of its body to this treatment. It even contrives to scratch the top of its head, by bringing the desired spot into the proper position at the precise moment of the glancing impact with the stone. The feat is delicate and deftly, as if an acrobat should in his somersaults comb his hair against a rock with no harm done every time.

Having enjoyed the use of a large aquarium for the study of fishes, it has been an object with me to anticipate their wants. Hence I have purposely given them scratching-stones properly adapted to their needs. I was surprised that a favorite object for this purpose was a large live river-mussel, the *Anodonta excurvata*. The corrugations of the shell, which mark its growth, form a series of smooth ridges, upon and against which, with their contortions of twists and bends and tilts, these fishes glance in scratching themselves. As to ichthyic emotion, one can not say much. That they enjoy these exercises, I am sure; and I almost think they know their benefactor, for they come at his call at feeding-time—though up to this present writing I have not observed anything that might be interpreted as a grateful recognition of benefits conferred; certainly nothing commensurate with the canny benediction, "God bless the Duke of Argyll!"

THE POISONS IN SPOILING FOOD.

By JULIUS STINDE.

IT is a well-known fact that food undergoing decomposition—spoiling, as it is termed—is unwholesome. Cases of poisoning that have occurred on the partaking of meat, fish, sausage, and cheese, that is, food of animal origin, will be readily recalled, for on such occasions the daily press has rarely failed to sound notes of warning. Until quite recently, however, the nature of these poisons was veiled in obscurity, and it is chiefly owing to the excellent investigations of Professor L. Brieger, at Berlin, that some light has been thrown on this subject.

As the study of the poisons of putrefaction is not only of great interest from the scientific point of view, but of the utmost importance in every-day life (for these poisons may be generated and produced daily in pantry and cellar), it seems desirable, in the interest of hygiene, to relate the new discoveries that have been made in this field, and review the earlier work done in it.

Schlossberger, who for some time past has been compiling statistics of cases of poisoning caused by food that had spoiled, records for Swabia alone, from the year 1793 to 1853, four hundred cases of sick-

ness caused by sausage-poison; of this number, one hundred and fifty terminated fatally. Cases where cheese was the cause of poisoning are also on record; the symptoms in these instances were those of typhus fever. The plague-like epidemic which occurred some time ago in the Volga district, and spread terror throughout Europe, was traced and ascribed to the diet of the population in those regions, which consisted almost exclusively of fish. Illness resulting from the eating of food that has spoiled is of so common occurrence that many will be able to recall instances of it from among the circle of their own friends and acquaintances.

Animal food that has entered into decomposition may generally be distinguished from fresh food by its presence proving unpleasant to the eye and nose. In fact, the nose may be considered as a sort of guardian of safety, for, generally speaking, whatever proves disagreeable to the sense of smell is injurious to the system. However, an ill-advised economy often causes these warnings to be not heeded; and among the lower classes we sometimes meet with so great an indifference, the result of habit, as to such indications, that frequently no distinction is made between food in a state of good preservation and that having a bad odor. To this circumstance must be ascribed the fact that diseases resulting from the poisons of putrefaction are of relatively much more frequent occurrence among the poorer ranks.

Cases of poisoning by food have, however, also been noted where no warning was given by the sense of smell. The explanation of this must be sought in the fact that the pure poisons of putrefaction are odorless compounds, and may probably occur without necessitating—at least, in any perceptible degree—the formation of products of decomposition which possess a strong odor.

The Danish scientist, Panum, had already ascertained that the poison of putrefaction is not destroyed by boiling. G. O. Weber, Hammer, and Schwenninger, further inferred from their investigations that it is of a chemical nature. Brieger, however, was the first clearly to establish this; he has succeeded in preparing the poisons of putrefaction in a pure state, and has given an explanation of their chemistry. He mixed pure white of egg with the juice from the stomach of a pig freshly killed, and allowed the mixture to stand twenty-four hours at a temperature of blood-heat. By means of a rather complex chemical process he succeeded in obtaining pure a small quantity of a substance, a few drops of an aqueous solution of which were sufficient to kill frogs in fifteen minutes. Rabbits died in the same time after inoculation with a larger quantity. From this it must be inferred that a poisonous principle was formed from the white of egg when it was subjected to artificial digestion.

From putrid meat Brieger succeeded in preparing a substance, neuridine, which acted as a poison as long as it was contaminated with other products of putrefaction; but when obtained in a state of

purity it was perfectly harmless. It is closely related to two substances which occur in the human system in its normal condition, namely, neurine, one of the constituents of the brain, and choline, which is present in the bile. By putrefaction, neuridine and the rather harmless choline are transformed into neurine, which is highly poisonous. It is a remarkable fact that neurine, which is identical with muscarine, the poisonous principle of a toad-stool (*Agaricus muscarius*), and which is a normal constituent of the human system, should prove so destructive when introduced into the body from an outside source.

The proof that the poisons of putrefaction are of a chemical nature is of the utmost importance. The fact affords an explanation of the presence of poisons which have been found in corpses, subjected to examination in cases where murder was suspected; for the poisons formed by putrefaction bear a certain resemblance to the alkaloids of the hemlock, strychnine, veratrine, etc. Thus, there was found in the corpse of General Gibbone, in Rome—whose sudden death excited a suspicion that he had been murdered by his servant—a virulent poison, which occurs in the larkspur. However, the rare occurrence of this poison led to a more careful examination of the substance found, which indeed bore a great resemblance to the vegetable poison referred to, but was ultimately recognized as having been formed in the corpse, for Professor Selmi, of Bologna, obtained the same substance from the corpse of another person, where every suspicion of poisoning was excluded.

Brieger was eminently successful in the preparation of the poisons found in corpses, and which are termed "ptomaines" by chemists. According to his investigations, they are created by the putrefaction of white of egg, meat, fish, cheese, gelatine, and yeast, all of them substances used as articles of food. The presence of moisture is an essential condition, whence it follows that the moist mixture of sausage-filling is especially well adapted to the formation of ptomaines. In accordance with this is also the observation that a great many cases of poisoning have occurred after the consumption of sausage or of fish that had been kept damp. A careful supervision of the markets and a destruction of all spoiled food of animal origin should be strictly insisted upon—especially so, as it is known that the poisons of putrefaction, when once formed, are not to be destroyed by boiling or by roasting. The action of the ptomaines is more virulent when they are introduced into the circulation through wounds than when they are brought into the stomach. Cuts and other wounds received while dissecting corpses have often been the cause of blood-poisoning ending in death. The savages of the New Hebrides are not only acquainted with the properties of poison of this kind, but make use of it in their wars. They plunge the points of their arrows, which are made of human bones and provided with grooves, into a corpse, about a week

old, and then coat them with the sap of a certain creeping plant. Before discharging the arrow they dip it into water. A serious wound caused by such an arrow is inevitably followed by death in from three to five days. Report as to a similar practice comes from the Narrinjeris, inhabitants of South Australia. They are said to wound their enemies by splinters of bone previously plunged into corpses undergoing putrefaction.

Jacob Doepler, in his "Theatrum Pœnarum," mentions a method of poisoning wells, the account of which was formerly discredited, but has become plausible in the light of modern researches. He states that people suffering from leprosy took of their blood, mixed it with herbs and toad-spawn, formed little pellets of the mixture, and threw the pellets weighted with stones into the wells. Many people who drank from these wells were taken with the same disease, and some of them died. This happened in the reign of Philip V of France, who caused all lepers cognizant of the outrage to be burned, and the Jews, who were accused of being the instigators of the crime, to be persecuted.

That many who drank of such water should become leprous seems very likely, inasmuch as the partaking of spoiled food causes eruption of the skin, nettle-rash, etc., in many persons ; chiefly are these symptoms to be noticed after eating spoiled fish. Of course the effects are more serious with some persons than with others. Some people are so sensitive that partaking of fish, seemingly fresh, will cause them inconvenience ; others are liable to suffer from a peculiar eruption of the skin after eating crabs or lobsters. Possibly the meat of these animals, even when in the normal condition, contains neurine sufficient to exert its influence on persons susceptible to it, while it may not affect others at all. In the maize-porridge which is called "polenta," and which is the chief food of a certain class of Italian working-men, there is formed, by putrefaction, during the hot months, a poison which causes "pellagra." This is an eruption of the skin, resembling erysipelas, which grows worse in time and finally induces death.

In connection with this subject, the investigations of Pouchet must be referred to. Pouchet isolated a ptomaine from the excreta of cholera-patients, which seemed to possess highly poisonous properties, for, when he tried to crystallize the salt he had obtained, he inhaled the fumes, and eighteen hours later was seized with chills and cramps in the limbs, while he also experienced an irregular pulse and nausea without vomiting. His assistant, who was not so much exposed to the fumes, was taken ill with the same symptoms, but not to the same extent.

The development of cholera and the processes of putrefaction are ascribed to the agency of minute living organisms, the bacilli, a great variety of which have been found in cases of putrefaction and infectious diseases. Professor Brieger has discovered in both fresh meat

and meat undergoing putrefaction, also in the white of eggs, the non-poisonous neuridine from which is formed the poisonous neurine. The bacilli decompose the neuridine and form neurine from it. Spread on fish they generate muscarine, the virulent poison also found in certain toad-stools. These bacilli hence produce a peculiar ptomaine, according to the soil in which they happen to be growing. We have as an instance the poison of the pellagra and of cholera, which, when formed in the human system, will exercise a most deadly effect upon it.

In every-day life, too, the ptomaines very often give proof of their presence. Heretofore, however, such cases have not always been well understood. The frequent inflammations of the fingers of persons engaged in washing dishes, etc., are due to this cause. The poisons of putrefaction, so easily formed, need only enter into a scratch or abrasion of the skin, and they will cause a slight poisoning. This is commonly termed having a "sore finger," and is rather unpleasant, but is generally soon cured. The best remedy for the evil is washing with soap, which acts like a mild disinfectant.

The investigation of these poisons of putrefaction is, however, by no means brought to an end by the results reached thus far. Much remains to be done in order to solve the new questions constantly arising. So far as practical life is concerned, it is evident that all food, be it of vegetable or of animal origin, must be regarded with suspicion as soon as the first signs of decomposition become noticeable. Especially should great care be taken in times of epidemics. Hygiene alone, in kitchen and cellar, is competent to guard against the evil!—*Translated for the Popular Science Monthly from Daheim.*

EELS AND THEIR YOUNG.

EELS are among the mysteries of this world. In spite of the way in which Dame Science has persistently poked her nose into most things, and has harried them and laid them bare, she has succeeded in finding out but little about eels and their mode of life. However, it would be rash to go as far in our confession of ignorance as a contemporary recently did, and declare that "we know next to nothing of eels beyond the periods of their migration." If we knew nothing more than that, we should indeed know but little, as in many places eels never migrate at all, but grow fat and flourish from year to year in the pond or lake where they were born, without ever leaving it to seek the brackish water of estuaries which some authorities deem necessary to their existence. The same writer who made the above remark asserts that the distinction between "shovel-nosed" and "pointed-nosed" eels is purely "fanciful," and accounts for the differ-

ence by saying that "most fish develop a shovel-nose when they are working up-stream." If this were the case, an eel would have a shovel-nose in the spring and a sharp nose in the autumn! Such a capability of altering his features would be certainly open to envy; but, unfortunately for this theory, the structure of the two fish is materially different, and the single fact that the shovel or broad-nosed eel has one hundred and fifteen vertebræ, while his sharp-nosed relative only possesses one hundred and thirteen is sufficient to prove the fallacy of the idea that the two fish are identical.

Of fresh-water eels as apart from their mighty cousin the conger, there are three distinct kinds—the sharp-nosed eel, the broad-nosed or frog-mouthed eel, and the snig. Of these three, the sharp-nosed eel is both the largest fish and the best eating, though some prefer the snig-eel as having a superior flavor. The snig, however, in spite of its excellence, has not the same value as the sharp-nosed eel; for it seldom, if ever, attains more than half a pound in weight. The sharp-nosed eel, on the contrary, attains an enormous size. One on record that was taken in the Medway, not far from Rochester, weighed thirty-four pounds, measured six feet in length, and had a girth of twenty-five inches. Another eel, taken in Kent, weighed forty pounds and measured five feet nine inches. Yarrell speaks of having seen at Cambridge the preserved skins of two which had weighed together fifty pounds; the heaviest twenty-seven pounds, the other twenty-three pounds. But these instances, though not to be regarded as apocryphal, are still very exceptional; and a very fair average weight for sharp-nosed eels is six pounds. Eels of even ten pounds weight are not common, and Mr. Frank Buckland speaks of one of that size as being the largest he had ever seen. From time immemorial eels have always been much esteemed by epicures, more perhaps in ancient days than they are now. Aristotle and Aristophanes both mention eels in terms of high praise; indeed, the former may be considered to have known more about eels than the contemporary we have already referred to, for he recognized at least two distinct species of eels. By the Egyptians eels were regarded with great abhorrence, as the embodiment of an evil demon; but other nations did not share the prejudice, for the Bœotians, who were celebrated for their eels, used them as sacred offerings. Misson, in his "Travels," tells of a vow made by the inhabitants of Terracina, a seaport of Italy, when besieged by the Turks. They vowed to offer twenty thousand eels a year to St. Benedict if he would deliver them from their peril. Whether a fond memory of stewed eels touched the saint we do not know, but the siege was raised, and the Benedictine monks got their eels every year from the virtuous and grateful inhabitants. The Venerable Bede mentions the eel-fisheries of Britain in his "History of the Anglo-Saxon Church," and an instance is quoted of the magnificence of the famous Archbishop Thomas à Becket that, when he traveled in France, "he ex-

pended the large sum of a hundred shillings in a dish of eels." Any one who could now sit down to cope with a dish of eels of the value of five pounds would indeed have gastronomic capabilities likely to make an alderman die of envy. But, in the eating of eels, excellent as they are, it is well to remember the advice given in the ancient medical book entitled "Regimen Sanitatis Salerniæ":

> "Who knows not physic should be nice and choice
> In eating eels, because they hurt the voice.
> Both eels and cheese, without good store of wine
> Well drunk with them, offend at any time."

For a long time the most extraordinary theories were accepted regarding the birth of young eels. Aristotle believed they sprang from the mud (wherein he was not far wrong, as eels deposit their spawn in mud and sand); Pliny maintained that young eels developed from fragments separated from the parents' bodies by rubbing against rocks; others supposed that they proceeded from the carcasses of animals; Helmont declared that they came from May-dew, and gave the following receipt for obtaining them: "Cut up two turfs covered with May-dew, and lay one upon the other, the grassy side inward, and then expose them to the heat of the sun; in a few hours there will spring from them an infinite quantity of eels." Of that ancient superstition of one's childhood that horse-hairs cut up and deposited in water would turn into eels it is hardly necessary to speak, for who can not remember those unpleasant little bottles, erst used for medicine, which garnished one's nursery, in which the propagation of eels from horse-hair was carried on with the profound faith of childhood? Eels generally shed their spawn in April, and, when not hindered, they almost invariably choose an estuary, where they scatter the spawn loosely in the sand or soil. But that an annual visit to the sea is by no means necessary to their existence is proved by the fact that many eels who inhabit inland ponds and lakes never visit the sea at all. A gentleman digging in the month of October in the gravel-banks of the river Stour found the place "alive with young eels, some of them scarcely hatched, at the depth of from five to fifteen inches"; and at one of the meetings of the British Association for the Advancement of Science a member stated that he had seen a considerable number of young eels rise up through a small opening in the sand at the bottom of a small stream, the Ravensbourne. The greater number of eels, however, do visit the sea, and the "passing up" a river of the young eels is one of the most curious sights of natural history. This passage of young eels is called *eelfare* on the banks of the Thames; and it has been thought by some that the term *elver*, which on the banks of the Severn is used indiscriminately for all young eels, is a corruption of the word *eelfare*. In the Thames this *eelfare* takes place in the spring, in other

rivers in the summer ; and some idea of the numbers of these young eels, each about three inches long, may be gathered from the record of Dr. William Roots, who lived at Kingston in 1832. He calculated that from sixteen to eighteen hundred passed a given point in the space of one minute of time. These baby-eels travel only by day and rest by night. In large and deep rivers, where they probably find the current strong, they form themselves into a closely compacted company, "a narrow but long-extended column," as it has been described ; but in less formidable streams they abandon this arrangement and travel, each one more or less at his own sweet will, near the bank. The perseverance of these little creatures in overcoming the obstructions they may encounter is quite extraordinary. The large flood-gates, sometimes twenty feet high, that are to be met with on the Thames would be sufficient, one would imagine, to bar the progress of a fish the size of a darning-needle. But young eels have a wholesome idea that nothing can stop them, consequently nothing does. As one writer says, speaking of the way in which they ascend flood-gates and such like barriers, "Those which die stick to the posts ; others which get a little higher meet with the same fate, until at last a sufficient layer of them is formed to enable the rest to overcome the difficulty of the passage." The mortality resulting from such "forlorn hopes" greatly helps to account for the difference of number between the upward migration of young eels and the return of comparatively few down-stream in the autumn. In some places these baby-eels are much sought after, and are formed into cakes which are eaten fried. On one occasion at Exeter two cart-loads of these little fish, not larger than darning-needles, were sold, each cart-load weighing four hundred-weight. They were sold for fourpence per pound. The term elver, which, as we have said, is in some places indiscriminately used to denote all young eels, in reality only belongs to the "transparent" eels which are occasionally found among their more opaque brethren. These elvers are so transparent that most of the internal organs and the action of the heart and blood-vessels can easily be seen. Little is known of them. They are not supposed to form a distinct species, for they have been found with the characteristics of both sharp-nosed and broad-nosed eels. They have been met with in the rivers in January as well as in June, and, even when caught and confined in a tank, they in no way grow out of their peculiar transparency ; so they have remained one of the many mysteries of the eel family till now. They are doubly interesting to study on account of this transparency. One of the greatest peculiarities possessed by eels is that they have a second heart situated in the extremity of their tails ; of course, in the transparent elvers the action of this heart can be more easily noted than in the ordinary eels. In all, however, its action is plainly manifest, especially if the fish has been out of water any time or exhausted, a fact known to the street venders of live eels, who therefore are care-

ful to cover their eels with sand to hide the caudal pulsations. Dr. Marshall Hall, who in 1831 discovered this secondary heart of the eel, says of it that "the action of this caudal heart is entirely independent of the pulmonic heart; while the latter beats sixty the former beats one hundred and sixty times in a minute. It continues for a very long time after the influence of the pulmonic heart is entirely removed." It is probably owing to this caudal heart that the eel's tail is so highly sensitive and so strong. Eels can almost use their tails like hands; as, for instance, if confined to a tank or bucket, they will grasp the edge with this hand-like tail, and by its help lift themselves bodily over. Eels are very clean feeders; if possible, they like their food alive, and in all cases it is most essential that it should be fresh. Even the slightest taint is too much for their keen sense of smell and taste. They are sometimes seen cropping the leaves of water-cresses, and other aquatic plants, as they float about in the water; but as a rule their food is altogether animal. They are immense devourers of spawn of all kinds of fish. There are certain well-known spawning-grounds in the Norfolk Broads, where the roach and bream collect in vast numbers to spawn in the spring. To these grounds the eels follow in hundreds. Mr. Davies, in his pleasant book on "Norfolk Broads and Rivers," speaks of this habit of the eels, and adds: "You can hear the eels sucking away at the spawn in the weeds; and they gorge themselves to such an extent that they will lie motionless on their backs on the gravel, with distended stomachs; and when caught by the bab they will frequently die during the night, instead of living for days, as an eel will otherwise do in a boat."

There are a good many ways of catching eels; the commonest, of course, being by the eel-bucks which are so often to be met with on the Thames. Eel-bucks that are intended to catch the sharp-nosed or frog-mouthed eels are set *against* the stream, and are set at night, as those two descriptions of eels feed and run only at night. The snig-eel, which is chiefly found in Hampshire, feeds by day; and fishermen have found by experience that snigs are only taken in the eel-bucks if they are set *with* the stream, instead of against it. In Norfolk, where immense quantities of eels are caught every year, the capture is mostly effected by eel-sets, which are nets set across the stream, and in which the sharp-nosed eel is the one almost invariably taken. Besides these eel-sets, however, the Norfolk Broadmen also fish for eels with "babs," which can hardly be called sport in any sense of the term. The "bab," or "clod," as it is sometimes called, is a number of lob-worms threaded on pieces of worsted, and all tied up in a bunch not unlike a small mop. The bab is then tied on to the end of a cord attached to a stout pole. The eel's teeth get entangled in the worsted as soon as he attempts to take the bab, and he can then be lifted out of the water either into the boat if the angler be in one, or else al-

lowed to drop off the line into a pail, which the angler should place on the bank at a convenient distance from his standing-place. Norfolk "babbers" frequently catch four stone weight of eels to a boat per night, especially in the spawning-grounds. Night-lines are also much used for eels. These are long lines, weighted heavily at each end and in the middle, and garnished with baited hooks one yard apart. "Sniggling," immortalized by Mr. Burnand in his "Happy Thoughts," is one of the most favorite ways of catching eels, and "stichering," a Hampshire method, is perhaps one of the most amusing, though the sticherer probably catches fewer eels than any other eel-hunter. The only apparatus used is an old sickle, worn short and chipped so as to present something of a saw-like edge; this is tied firmly on to a light pole about twelve feet long. Armed with these the sticherers betake themselves to the water-meadows. In the wide, deep drains used for irrigation eels abound, and the object of the sticherer is to thrust the sickle under the eel's body, and, with a sudden hoist, to land him on the bank, from which he is transferred to the bag. That there is every chance, when on a stichering party, of having your eye poked out, or your ear sawn off, of course only adds the necessary amount of danger and pleasurable excitement, without which all sport is tame. Of all forms of eel-capture, however, there is none to compare to spearing, of which there are two methods. The Norfolkmen mostly use "picks" formed of four broad blades, spread out like a fan, between which the eels get wedged. These are mounted on long, slender poles, to enable them to be thrust into the mud, where the "picker" notices the tell-tale bubbles rise which denote the presence of "Anguilla." Eel-spearing of this kind takes place chiefly in winter, but there is another form of this sport called "sun-spearing," which is much sought after in the Irish loughs during the months of June and July. In the early sunny mornings at that time of the year, when the water seems to be principally composed of sunbeams, with a little hydrogen and oxygen added, the sun-spearer sallies forth in any little boat he can lay his hands on. Standing up in the bows, and, if alone, using his spear to propel the boat gently along, he steals over the crystal waters of the lough. Presently he sees the gleam of the "silver" eel as he lies quietly at length on the sandy bottom. The spearer takes aim; there is a sudden "splitting of the atmosphere," as Mark Twain would say, a splash, and either Anguilla comes up writhing on the twelve close-set teeth of the sun-spear, or the spearer has taken a header into ten feet of water. If the latter is a tyro at the apparently simple art of sun-spearing, it may safely be prognosticated that, if he makes acquaintance with the eel he is after, the meeting will be more likely to take place under water than above it.

Eels have the immense merit in the eyes of all careful people that they more than repay any cultivation bestowed upon them. There is always a demand for eels, and they never seem to be out of season.

The London market is chiefly supplied from Holland, the eels being brought over alive in welled vessels. Queen Elizabeth gave a free mooring to these Dutch skoots, and this privilege has been taken advantage of up to the present time. The Dutch eels, however, are very much inferior in flavor to the English, and it seems, therefore, somewhat of a pity that they should have almost a monopoly of the London market. The Norfolk eels, that are caught in such huge quantities, are nearly all sent to Birmingham and the Black Country. In Scotland eels are looked upon with abhorrence, consequently eel-fisheries may be said not to exist there. In Ireland, however, the eel-fisheries are enormously valuable; the eel-weirs on the Erne are said to bring in five or six thousand pounds sterling a year. At Ballisodare the eel-fisheries were found to greatly increase in value by hanging loosely plaited ropes of straw or hay over any obstructions which would be likely to bar the course of the elvers up-stream. These ropes act as ladders, up which the elvers climb, and the immense annual destruction we have already spoken of is averted. Eels cost but little to cultivate, never fail to find a good market, and are one of the richest and most nutritious forms of food possible to find; surely, therefore, in all questions of cheap food-supply they should receive the highest attention. The late Mr. Frank Buckland showed his usual good sense when he declared that the English eel-fisheries were not half developed, and that they deserved considerably more attention than they had hitherto got. That they should soon get this attention must be the hope of all those who do not like to see the good gifts of Nature contemptuously thrown aside and disregarded.—*Saturday Review.*

SKETCH OF GEORGE ENGELMANN, M. D.

THE United States has had many botanists who, making the best use of the immense resources of fresh material which our large and virgin country afforded, have made extensive and important additions to the scope of their science. None among them, perhaps—unless we make a single exception—has done better work in this line and made more valuable contributions than Dr. George Engelmann. "More than fifty years ago," says Dr. Asa Gray, in his sketch of him, "his oldest associates in this country—one of them his survivor—dedicated to him a monotypical genus of plants, a native of the plains over whose borders the young immigrant on his arrival wandered solitary and disheartened. Since then the name of Engelmann has, by his own resources and authorship, become unalterably associated with the buffalo-grass of the plains, the noblest conifers in the Rocky Mountains, the most stately cactus in the world, and with most of the asso-

ciated species, as well as with many other plants, of which perhaps only the annals of botany may take account."

George Engelmann was born at Frankfort-on-the-Main, February 2, 1809, and died in St. Louis, Missouri, February 4, 1884. He came of a family of clergymen who had been settled for several generations as pastors at Bacharach on the Rhine, and was the eldest of thirteen children. His father was director of a school for girls at Frankfort. He went through the usual course of gymnasial instruction in that city, and there acquired his taste for scientific studies, which was stimulated under the inspiration given by the Leuckenberg Philosophical Society, a body to which the journey of Rupell, one of its members, in Nubia, Kordofan, Arabia Petræa, and Abyssinia, had given considerable renown. In the spring of 1827, when he was eighteen years old, he entered the University of Heidelberg, where he met as fellow-students Alexander Braun, who afterward became an eminent botanist, and Carl Schimper, whose name is associated with the early history of phyllotaxy. A close fellowship, which lasted through Braun's life, sprang up between him and Braun, and they were accustomed, at their evening meetings, to discuss questions of the physiology and morphology of plants. Here he also met and made friends with Agassiz, who afterward became a brother-in-law of Braun's. In 1828 he removed, in consequence of a political incident at Heidelberg, to the University of Berlin, whence, after two years of residence there, he went to Würzburg, and there took the degree of Doctor of Medicine in 1831. His graduating thesis, "*De Antholysi Prodromus*," a morphological dissertation on the study of monstrosities, illustrated with his own drawings, was an important contribution to teratology, and has held a prominent place in the literature of morphology. Having been brought under the notice of Goethe, who had forty years before published an essay on the morphology of plants, only four weeks before his death, that great author testified his appreciation of the mastery which the young botanist had attained of the subject by offering to present to him the unpublished notes and sketches which he had accumulated. Engelmann's original manuscript of the thesis, with his drawings, is now preserved in the library of the Herbarium of Harvard University.

This pamphlet, written in Latin, and that not the most classic, has been compared, in "Nature," by Mr. Maxwell F. Masters, with the more elaborate "Élémens de Tératologie Végétale" of Moquin-Tandon, written nearly ten years later, or in 1841. Moquin's work, says Mr. Masters, "is written in a style which even a foreigner can read with pleasure. Its method, too, is clear and symmetrical; but when we compare the two works from a philosophical point of view, and consider that the one was a mere college essay, while the other was the work of a professed botanist, we must admit that Engelmann's treatise, so far as it goes, affords evidence of a deeper insight into the nature

and causes of the deviations from the ordinary conformation of plants than does that of Moquin."

Engelmann spent a part of 1832 in Paris, in the study of medicine and science, along with Braun and Agassiz. Some of his relatives had determined to make investments in land in the Mississippi Valley, and one of them had settled in Illinois, near St. Louis. The others invited him to visit the country, as an agent for them, and he accepted the proposition, being moved to do so, one of his biographers suggests, by the expectation of finding in America an interesting field of botanical research. He sailed from Bremen in September, 1832, landed in Baltimore, after a voyage of six weeks, visited Philadelphia, where he made the acquaintance of the botanist Nuttall, and arrived at a friend's farm in Missouri in the middle of the ensuing winter. He resided on the farm of his uncle Fritz, near Belleville, Illinois, till the spring of 1835, when he undertook a horseback-journey through Southwestern Illinois, Missouri, and Arkansas, down to Louisiana. After nearly dying of fever during the summer in the swamps of Arkansas, he returned to St. Louis, then a frontier town of eight thousand inhabitants, and began the practice of medicine there in December. He combined with his medical practice, which was very successful, and became so extensive as to make him one of the leading physicians of St. Louis, botanical investigations as a side pursuit. He made collections which he sent, with his own scientific descriptions, to the European museums, and also for his own herbarium. It was through one of h is herbariums, which Dr. Gray examined in Berlin, that that botanist became acquainted with Dr. Engelmann's studies; and when the latter passed through New York on his return from his marriage-journey to Kreuznach, in 1840, Dr. Gray embraced the opportunity of making his acquaintance, and formed with him a life-long friendship.

Dr. Engelmann made a second botanical excursion south, to Arkansas in 1837. His first botanical work, "A Monography of North American Cuscutineæ," or dodders, was published in 1842, in the "American Journal of Science," and made him known throughout the scientific world. Till this time only one species of dodder indigenous to the United States was known. Engelmann's monograph treated of fourteen species, all found within the Mississippi Valley, or east of it. A more systematic treatise, published in the "Transactions of the St. Louis Academy of Sciences," in 1859, after investigation of the whole genus in America and Europe, gave the characteristics of seventy-seven species.

The botanical chapter in the report of Colonel Doniphan's expedition of 1846 and 1847 to New Mexico, published by the Government in 1848, was prepared by Dr. Engelmann from material furnished by Dr. Wislizenus, his colleague in the medical profession, who was a member of the expedition.

In 1849 Dr. Engelmann published, in the "Memoranda of the American Academy of Arts and Sciences," the "Plantæ Fendlerianæ," thereby, says his biographer in the St. Louis "Universe," "drawing from obscurity another German-American botanist, August Fendler." Fendler and he had become acquainted on a governmental expedition to the Rocky Mountains, to which the former was attached as engineer. He was afterward engaged for two years, upon Engelmann's recommendation, in classifying and arranging the Henry Shaw collections of plants. He traveled in the Rocky Mountains, California, Mexico, Central America, and Brazil, and died in the Island of Trinidad in 1882. His name, the "Universe" adds, can not be forgotten in the history of the American flora. A number of plants are named after him, among them one of the handsomest cactuses, the *Cereus Fendleri.*

Dr. Engelmann's work upon the cactus family is styled by Dr. Gray, in the "American Journal of Science," most extensive and important, as well as particularly difficult, and his authority the highest. "He essentially for the first time established the arrangement of these plants upon floral and carpological characters." This work was begun in the report of the Doniphan expedition, and was continued, by his account in the "American Journal of Science," in 1852, of the giant cactus of the Gila (*Cereus giganteus*) and an allied species; "by his synopsis of the *Cactaceæ* of the United States, published in the 'Proceedings of the American Academy of Arts and Sciences,' 1856; and by his two illustrated memoirs upon the Southern and Western species, one contributed to the fourth volume of the series of 'Pacific Railroad Expedition Reports,' the other to Emory's 'Report on the Mexican Boundary Survey.' He had made large preparations for a greatly needed revision of at least the North American *Cactaceæ.* But although his collections and sketches will be indispensable to the future monographer, very much knowledge of this difficult group of plants is lost by his death. Upon two other peculiarly American groups of plants, very difficult of elucidation in herbarium specimens, *Yucca* and *Agave*, Dr. Engelmann may be said to have brought his work up to the time. Nothing of importance is yet to be added to what he modestly styles 'Notes on the Genus *Yucca*,' published in the third volume of the 'Transactions of the St. Louis Academy,' 1873, and not much to 'Notes on *Agave*' illustrated by photographs, included in the same volume and published in 1875."

Other special works mentioned by Dr. Gray are those on *Juncus*, in the second volume of the "Transactions of the St. Louis Academy"; *Euphorbia*, in the fourth volume of the "Pacific Railroad Reports," and in the "Botany of the Mexican Boundary"; *Sagittaria* and its allies; *Isoetes;* the North American *Loranthaceæ; Sparganium;* certain groups of *Gentiana;* and some other genera. "Of the highest interest, and among the best specimens of Dr. Engelmann's botanical work,

are his various papers upon the 'American Oaks' and the *Coniferæ*, published in 'Transactions of the St. Louis Academy' and elsewhere, the results of long-continued and most conscientious study. The same must be said of his persevering study of the North American vines, of which he at length recognized and characterized a dozen species—excellent subjects for his nice discrimination, and now becoming of no small importance to grape-growers, both in this country and in Europe. Nearly all that we know scientifically of our species and forms of *Vitis* is directly due to Dr. Engelmann's investigations." The list of his papers published in "Coulter's Botanical Gazette" for May, 1884, which is not quite complete, contains about a hundred entries.

Dr. Engelmann made several journeys of considerable length in the interest of science, or for geographical observation. Two of them were to the Rocky Mountains and Colorado, and New Mexico; a longer tour was to the Appalachian Mountains in Tennessee and North Carolina; and a third, in 1880, to the Pacific coast and Oregon, where "he saw for the first time in their native home the plants described thirty years previous."

Dr. Engelmann's meteorological observations constitute another important feature of his scientific work. They were begun as soon as he had established himself in St. Louis, and were kept up unintermittingly from New-Year's-day of 1836, to February 2, 1884—two days before his death—or during a period of forty-eight years. He visited his instruments regularly and systematically, every morning at seven o'clock, at noon, and at nine o'clock in the evening; and "even in the last week he was seen sweeping a path through the snow in his garden to reach his maximum and minimum thermometers." His last publication was a digest of the thermometrical part of these observations. In offering this paper to the St. Louis Academy of Sciences at nearly the last meeting of that body which he attended, he apologized for not waiting till the half-century had been completed before presenting his results, saying that they could not be appreciably different after two or three years more. He had been endeavoring to discover some law governing the weather, but had failed to do so. A member of the Academy expressed the hope that the half-century would be completed. Dr. Engelmann replied that he had some misgivings on the subject.

Dr. Engelmann was known, through his life in St. Louis, as a public-spirited citizen, who always had the interests of the town unselfishly at heart. He also showed a practical interest in the efforts of the European peoples to gain their freedom; and, when the revolutions broke out in 1848, he became the head of an organization which was formed at St. Louis to assist them. He took part, in 1836, in the organization of the "Western Academy of Science," which, coming before the times were ripe for such an organization, had only a short

life. He was the first president, and served in several subsequent terms as president, of the "Academy of Science of St. Louis," organized in 1856; he always had something of interest to communicate at its meetings; and, under the inspiration he gave it, it became a living and active body, though not large in numbers.

Dr. Engelmann with his family visited Europe in 1868, when his son entered upon the pursuit of his medical studies at Berlin. Again, a few months after the death of Mrs. Engelmann, suffering from ill health, he went to Germany in the summer of 1883, seeking the benefits of a change of scene. He returned home, having gained a considerable accession of strength. His death was finally accelerated by a sudden cold.

His companions, says the "Universe," "will never forget his pluck and energy, his enthusiasm and diligence, and the geniality and attentiveness shown toward all of them." He was accustomed always to re-examine established suppositions in order to receive new light through newly discovered facts. In all his doings he was very determined; "he had no great esteem for speculation, but relied only upon facts gained by hard and strenuous study. He was a man of strict scientific truth. He could examine a plant again and again in all the stages of its growth, microscopically and chemically, before he came to a conclusion, and what he then wrote was the accurate result of his painful observations, without any hypothetical suppositions. "Nothing," says Dr. Gray, "escaped his attention; he drew with facility; and he methodically secured his observations by notes and sketches, available for his own after-use and for that of his correspondents. But the lasting impression which he has made upon North American botany is due to his wise habit of studying his subjects in their systematic relations, and of devoting himself to a particular genus or group of plants (generally the more difficult) until he had elucidated it as completely as lay in his power. In this way all his work was made to tell effectively."

Not very many of those, Dr. Gray adds in another part of his sketch, "who could devote their whole time to botany have accomplished as much" as did this doctor in practice, who could give it only the time he could spare from his duties as a physician. "It need not be said," Dr. Gray continues, "and yet perhaps it should not pass unrecorded, that Dr. Engelmann was appreciated by his fellow-botanists both at home and abroad; that his name is upon the rolls of most of the societies devoted to the investigation of Nature; that he was 'everywhere the recognized authority in those departments of his favorite science which had most interested him'; and that, personally one of the most affable and kindly of men, he was as much beloved as respected by those who knew him."

EDITOR'S TABLE.

LABOR TROUBLES.

WHATEVER we may fail to see nowadays when we take up a newspaper, there is one thing certain to meet our eyes on the first page, with a continuation probably on other pages. We refer, of course, to the perpetually recurring accounts of strikes and other labor troubles. If we do not see our way out of these difficulties, it is not for want of having our attention repeatedly and powerfully directed to them; nor is it because our interests are not seriously concerned in the matter. Yet we are not aware that recent discussion has thrown any important light either upon the cause of the troubles or upon the method of their cure. In this there is room for the application of scientific principles. All the facts that have any bearing on the case require to be carefully gathered. We should ask not only what are the open pretensions of the parties to the struggle, but what are their secret thoughts and purposes. We fear that there is a great deal of working in the dark, simply from lack of information as to "bottom facts." Platforms and manifestoes never tell the whole truth. They may formulate a temporary *modus vivendi;* but they never state ultimate intentions. Consequently, as long as we confine our attention to these, we are liable to continual misunderstandings. For example, some are disposed to think that the legal establishment of boards of arbitration would meet the present difficulties. The idea appears to us, on the other hand, absurd. Those who adopt it do so, no doubt, on the strength of the declarations made on either side of a desire for a reasonable settlement of disputes. We reject the idea, because we suspect that no definite sense can be attached to the word "reasonable" or the word "equitable," as used in the public statements either of labor unions or of the great employers of labor. Each side has its own secret tendency, and until we get at that we are all in the dark. Meanwhile it seems certain that neither capitalist nor workman would consent to have a course dictated to him by any form of official authority. There is no getting over the homely maxim that everybody knows his own business best; and we can hardly understand how any rational man can bring himself to believe that any large business could be run, against the judgment of its head, upon lines laid down by outsiders. Still more difficult is it to understand how, if the workmen were dissatisfied with the decision of an official board, they could be forced to respect that decision.

The proposition simply affords another example of the readiness with which in these days government or legislative interference is invoked for the settlement of difficulties. What common sense or the instinct of justice between man and man can not, or *apparently* can not, effect, that the Legislature, in its infinite justice and wisdom, is asked to undertake. Such efforts tend only to obscure the real elements of the situation. We may be mistaken, but it seems to us that the position taken to-day by the laboring classes (to use the common expression) involves the principle that free competition for wealth between man and man in society should not be allowed. Every intelligent man, whatever his status in society, would allow that were all the wealth in the world to be redistributed equally to-day, a year would not elapse, under the *régime* of free competition, before there would again

be marked inequalities of fortune, while, in ten years, there would be millionaires at one end of the scale and beggars at the other. This, we believe, is what many object to, though they do not always avow it to themselves. The cry seems to go up from the multitude, "Save us from the strong man, or we shall take the law into our own hands and make an end of his wealth, if not of him!" The common idea of the capitalist is that he is a man who absorbs into his own personality and possessions all the richest juices of the laboring man's organization. The working-man toils, and the capitalist reaps all the best fruits of his toil, leaving to the former a mere subsistence, and a more or less precarious one at that. A fact, however, that is generally lost sight of is that, but for the capitalist, labor would not be so productive as it is. The share taken by the capitalist is not deducted from a total product which would equally have existed had he never appeared upon the scene with his experience, his talent for direction, his enterprise, his pecuniary resources, but from a product in large part probably due to his personal usefulness. What an army under a skillful general, and with a well-supplied commissariat, can accomplish, is something very different from what it can accomplish without any superior leadership. This obvious truth should certainly be taken into account in striking the balance between the capitalist and those whose labor he employs.

If, then, the secret aspiration of the laboring class, or at least of a large portion of it, is, to be protected against the competition of men of subtiler brains and stronger resolution, the question may be asked, What is the secret thought of the capitalist class, the men who have these superior resources, or whose fathers had them, and who consequently rule in the industrial world? If it is true that labor would not be so productive as it is, that wealth would not be created in the same quantity, but for the organizing power of the captains of industry, it is also true that *all* wealth is a social product, requiring a concurrence of efforts to produce it, and a social medium to give it its value. What would the wealth of the Indies have been to Robinson Crusoe on his desert isle? His man Friday was a greater fortune to him than would have been the riches of the Rothschilds. These considerations suffice to show that, in whatever light the holders of great wealth may regard themselves, they *should* regard themselves not as mere irresponsible giants of finance, at liberty to toss about millions as it may please their vanity or their ambition, but as bound to lives of social usefulness. The secret thought, we fear, of too many very rich men is, that they are absolutely irresponsible to society, and quite at liberty to dismiss from their minds every other aim than that of adding to their already great possessions. Their secret prayer would be, to be delivered from all bondage to public opinion, so that they might pursue an unchecked career in gratifying their selfish ambition. Cripple or debauch public opinion, and the watering of stocks, the making of corners, and all the rest of the diabolical jugglery of the modern financial world can be carried on without apprehension, as without a qualm. But public opinion, we trust, is not going to be permanently crippled or debauched. True, there is an altogether inordinate social admiration of great wealth, as Mr. Spencer has forcibly pointed out; but the feeling, on the whole, is growing, that great wealth means proportionate social responsibility. It is not to be concluded from this that the chief business of the capitalist is to endow hospitals, libraries, or universities. By no means; it is well that every one in the community should contribute to these things according to his ability, and realize for himself the blessedness

of giving to worthy objects. The capitalist could not render a much worse service to the community than to take entirely off other people's shoulders burdens that it is best every one should bear in some degree. No, but the capitalist should certainly employ his great advantages and resources in bringing the conditions of a really human life within the reach of ever-increasing numbers of human beings. It does not do to regard our fellow-men as mere ciphers, as pawns on the chess-board of life, to be used or sacrificed according to the exigencies of the game. Mr. Gladstone was greatly laughed at some years ago by the cynical school so largely represented in English journalism, particularly in weekly journalism, because he had used the argument that, after all, the voters whom he proposed to enfranchise were "our own flesh and blood." For all that, the truth he hinted at is a good one to remember. Certainly it is a bad one to forget; and terrible trouble may come of carrying forgetfulness of it too far. Our object in this brief article has been mainly to express the opinion that much good would come of greater frankness on both sides in the now pending labor contests. If both sides would really talk business, which they can only do by expressing their real thoughts and purposes, there would be more hope of a permanent reconciliation. We believe that, when it came to the rub, thousands of the working class would shrink from pronouncing against the *régime* of free competition; while the holders of wealth would certainly be slow to formulate the doctrine of social irresponsibility.

"*DON'T!*"

A LITTLE manual of social proprieties, published under the name of "DONT!" has obtained a wide circulation; and, as its negative precepts are inspired by much good sense and good taste, we have no doubt the tiny book will prove of real value. But, while good social habits are well worth forming, good intellectual ones are at least of equal importance; and it occurs to us that there is ample room for a manual that, in a series of brief and pithy sentences, would place people on their guard against the most obvious intellectual errors and vices. Possibly the objection might be raised that, while everybody wants to be cured of his or her social solecisms (if the expression may be permitted), none so little desire to be cured of intellectual faults as those who are most subject to them. Who, it might be asked, applies the moral denunciations of the pulpit to himself? Who would apply to himself the cautions of your proposed manual? Granted, we reply, that it is easier to bring home to the individual conscience the sin of eating with a knife than the sin of reasoning falsely or acting unjustly, we should still be glad to see a telling compilation of the most needed "Dont's" for the use of all and singular who make any profession of an independent use of their intellects. Some of the maxims would be commonplace; but then the object would not be to lay down novel truths so much as to enforce old ones. Let us throw out a few at random, by way of a start:

Don't think that what you don't know is not worth knowing.

Don't conclude that, because you can't understand a thing, nobody can understand it.

Don't despise systems of thought that other men have elaborated because you can not place yourself at once at their point of view.

Don't interpret things too much according to your own likes and dislikes. The world was not made to please anybody in particular, or to confirm anybody's theories.

Don't imagine that, because a thing is plain to you, it ought to be equally so to everybody else.

Don't insist on making things out simpler than they really are; on the other hand—

Don't affect far-fetched and over-elaborate explanations.

Don't be overwise. Why should you make a fool of yourself?

Don't imagine that anything is gained by juggling with words or by evading difficulties.

Don't refuse to change the point of view of a question, if requested by an opponent to do so. A true conclusion can not be invalidated by any legitimate process of argument.

Don't be inordinately surprised when a man who knows quite as much as you do on a given subject, and perhaps a little more, does not agree with you in your conclusions thereon. Try the effect of being surprised that you don't agree with him.

Don't keep on hand too many cut-and-dried theories. A foot-rule is a convenient thing for a carpenter to carry about with him; but a man who is always "sizing up" other people's opinions by a private rule of his own is apt to be a bore.

Don't be in a hurry to attribute bad motives or dishonest tactics to an opponent. Try to get an outside view of your own motives and tactics.

Don't refuse to hold your judgment in suspense when the evidence is not sufficient to warrant a conclusion.

Don't imagine that, because you have got a few new phrases at your tongue's end, you have all the stock-in-trade of a philosopher, still less that you are a philosopher.

Don't try to express your meaning till you have made it clear to yourself.

Don't argue for the sake of arguing; always have some practical and useful object in view, or else hold your peace.

Don't grudge imparting what you know, and do it with simplicity.

Don't prosecute any study out of idle curiosity or vanity. If you have time for intellectual work, be a serious and honest worker.

Don't be too eager to "get credit" for what you do.

Don't undervalue the work of others.

Here we have a score or so of maxims of the prohibitive kind, and the number might be indefinitely increased. There is no doubt the intellectual progress of the world might be hastened, and the good order and harmony of society greatly improved, if these precepts and others like unto them were more carefully observed. Whether we get another "Don't" manual or not, sensible people should think of these things, and try to bring their intellectual habits at least up to a level with their social ones.

LITERARY NOTICES.

INTERNATIONAL SCIENTIFIC SERIES. VOL. LIV.

Comparative Literature. By Hutcheson Macaulay Posnett, M. A., LL. D., F. L. S., Barrister-at-Law, Professor of Classics and English Literature, University College, Auckland, New Zealand, author of "The Historical Method." New York: D. Appleton & Co. 1885.

This is in many ways a remarkable book. For some years, not many to be sure, a certain number of critics have been urging the necessity of applying to the study of literature the principles of scientific treatment which has brought forth rich fruit from many seemingly arid sources. While they have been apostrophizing vaguely on the general need of some such change, and generally with but little apparent success, we have in this volume tangible proof of the good results that the method can produce in competent hands. Naturally enough, the mere novelty of the theory excites angry surprise; then, too, the venerable habit of regarding literature and science as two irreconcilable poles of thought has opposed the recognition of the inevitable advance of science into every department of investigation, and it has been held—it is still held—that genius is something which defies analysis as it defies definition; that it was only necessary to have a creative mind to create masterpieces; and that to attempt to show how

any great man in the past wrote, what influences controlled and directed him, was mere presumptuous extravagance. We are also told that literature is made up of beauty, and is only to be enjoyed; students of its principles are carefully warned off from its treasures. Yet one might as well tell a botanist that flowers are only to be enjoyed, or a mineralogist that gems exist but for the purpose of evoking admiration; the sciences of these imaginary men would survive such impossible advice, and the existence of these sciences, it may be well to notice, has not yet tended to diminish the interest or delight in the objects with which they are concerned.

If, then, the reasonableness of some form of the scientific study of literature may be acknowledged, this book, which contains a serious application of the results of sociological investigation to various early literatures, is well worthy of attention. The conditions of early society have been ascertained by long and careful investigation; the comparative study of its beginnings has been facilitated by observing phenomena still existent among rude races, and in this volume Mr. Posnett applies to letters the upshot of these studies. Naturally, it is to the literature of Greece that he turns with especial interest, for, besides its importance to all later civilizations, it bears distinctly the marks of autochthonous growth. Inasmuch as society developed from the communal form of the clan into the fuller expression of individuality, it becomes important to examine the growth of literature by the light of these discoveries, as this author has done, and the result is most gratifying. It is obvious that any one who approaches Greek territory with such intentions is sure to stir up a hornets' nest. Anything that tends to show that the sacred spirit of Hellas has grown up under conditions that may be explained by studying other races is held to lay profane fingers on a carefully guarded art. Mr. Andrew Lang has tasted some of the wrath of zealous scholars who have not fancied his proof that the stone age of Greece was like the stone age of every other race; and it is hard to conceive the miserable fate that awaits Mr. Posnett for daring to compare the early Doric choral dances to the buffalo-dance of the North American Indians. Yet he has done this; and, moreover, he has shown how the customary belief of clans in inherited guilt and in vicarious sacrifice survived in the plays of Æschylus and Sophocles, only to disappear in those of Euripides with the growth of individuality. His proof of the limitations of the Greek ideas through these bonds is most valuable. Here at last we have something like solid ground to take the place of *a priori* hypothesis. To enforce his points he has brought together abundant testimony from the early Hebrew, Sanskrit, Persian, Chinese, Japanese, Arabic, and other literatures, which is the only way in which this vast subject can be properly studied. The study of Greek literature alone has led to extravagant notions of the miraculous force of genius; by examining all the testimony, though the task is an arduous one, sounder ideas will prevail.

Space is lacking for even a statement of all that is contained in this excellent book, but it may be said that every student of literature will find his reward in mastering its pages. No one will agree with everything that Mr. Posnett says, but whoever learns to apply to the foundation of literature the light obtained from the study of contemporary society may be sure that he is on the right path. That is the whole secret: to study literature as but a part of man's development, not as a separate, divinely inspired entity—a mysterious thing created by incomprehensible genius.

Hunting Trips of a Ranchman. By Theodore Roosevelt. New York: G. P. Putnam's Sons. Pp. 347. Price, $3.50.

The character of this book is further described by its sub-title, "Sketches of Sport on the Northern Cattle-Plains"; and this makes it appropriate to begin the story with a description of those plains and their — for the time at least — great industry. They lie in the basin of the Little Missouri River, and "stretch from the rich wheat-farms of Central Dakota to the Rocky Mountains, and southward to the Black Hills and the Big Horn Chain, thus including all of Montana, Northern Wyoming, and extreme Western Dakota." The region is a nearly treeless one, of light rainfall, cut up by streams of the most capricious character, diversified with deserts of alkali and sage-

brush, prairies, rolling hills, and fantastically carved and colored "bad lands." The country was won from the Indians only about half a dozen years ago, and was almost immediately occupied by the cattle-herders, owning from hundreds to tens of thousands of head, and occupying land of extent to correspond, with not very exactly defined boundaries and no legal titles. With them came the now famous cowboys, of whom and their habits Mr. Roosevelt gives a very interesting description. The home-life of this wild region, which is, of course, usually a bachelor's life, with cowboys for neighbors, and rough enough, forms the subject of a lively running sketch, passing from topic to topic, after which the reader is introduced to the game in its several kinds—waterfowl, grouse, jack-rabbits, wild turkeys, and the larger animals. The white-tailed deer is the best known and most widely distributed of all the large game of the United States, and the kind which under any sort of decent treatment is probably likely to stay longest at large among us. These deer have the capacity of living in a region even when it has become thickly settled, and making themselves at home among tame cattle, and still exist in nearly every State. They "are very canny, and know perfectly well what threatens danger and what does not; keep themselves concealed in the densest thickets of the river-bottoms, and at the first intimation of danger steal off noiselessly almost from under the eyes of the hunter." Mr. Roosevelt tells of the best ways of killing them, but our interest is in the ways they have of keeping from being killed, in which we hope they will improve. The black-tail deer, more important animals in some respects, in their unsophisticated state are very easy to approach, but a short experience of danger on their part changes their character, and when hunters are often afoot, they become "as wild and wary as may be." They would be extremely difficult to hunt except for their inordinate curiosity, which gives them the habit of turning round every once in a while, stopping, and looking at their pursuer. Antelopes, or prong-horns, are also very wary game, but may be betrayed by their morbid curiosity or their unhappy liability to be thrown into a panic. No other plains game, except the big-horn, is as shy and sharp-sighted; "and if a man is once seen by the game the latter will not let him get out of sight again, unless it decides to go off at a gait that soon puts half a dozen miles between them. It shifts its position so as to keep the hunter continually in sight, . . . and after it has once caught a glimpse of the foe, the latter might as well give up all hopes of getting the game." The big-horn, or mountain sheep, "are extremely wary and cautious animals, and are plentiful in but few places." They are almost the only kind of game on whose haunts cattle do not trespass. They live on the rocks, and are not annoyed by rival claimants to their sterile estates. Their movements are not light and graceful like those of the antelopes, but they have a marvelous agility which proceeds "from sturdy strength and wonderful command over iron sinews and muscles." There is probably no animal in the world their superior in climbing; and "the way that one will vanish over the roughest and most broken ground is a perpetual surprise to any one that has hunted them." Regarding the buffalo, Mr. Roosevelt observes that its rapid extermination "affords an excellent instance of how a race that has thriven and multiplied for ages under conditions of life to which it has slowly fitted itself by a process of natural selection continued for countless generations, may succumb at once when these surrounding conditions are varied by the introduction of one or more new elements, immediately becoming the chief forces with which it has to contend in the struggle for life." These new elements are the barbarity of civilized man in hunting the buffalo, and the greed of the cattle-herders for its pasture-lands; and their presence has made the other conditions and habits which were most favorable to the preservation of the animal to contribute to its extinction. Happily, "events have developed a race of this species, known either as the wood or mountain buffalo, which is acquiring, and has already largely acquired, habits widely different from those of the others of its kind. It is found in the wooded and most precipitous portions of the mountains, instead of on the level and open plains; it goes singly or in small parties, instead of in

huge herds; and it is more agile and infinitely more wary than its prairie cousin. The formation of this race is due solely to the extremely severe process of natural selection that has been going on among the buffalo-herds for the last sixty or seventy years." Elk were formerly plentiful all over the plains, but they have been driven off the ground nearly as completely as the buffalo. They are still, however, very common in the dense woods that cover the Rocky Mountains and the other great Western chains; but they are unfortunately one of the animals seemingly doomed to total destruction at no distant date. Already their range has shrunk to far less than one half its former size. "Ranged in the order of the difficulty with which they are approached and slain," says Mr. Roosevelt, "plains game stand as follows: big-horn, antelope, white-tail, black-tail, elk, and buffalo. But, as regards the amount of manly sport furnished by the chase of each, the white-tail should stand at the bottom of the list, and the elk and black-tail abreast of the antelope. Other things being equal, the length of an animal's stay in the land, when the arch foe of all lower forms of animal life has made his appearance therein, depends upon the difficulty with which he is hunted and slain. But other influences have to be taken into account. The big-horn is shy and retiring; very few, compared to the whole number, will be killed; and yet the others vanish completely. Apparently they will not remain where they are hunted and disturbed. With antelope and white-tail this does not hold; they will cling to a place far more tenaciously, even if often harassed. The former, being the more conspicuous and living in such open ground, is apt to be more persecuted; while the white-tail, longer than any other animal, keeps its place in the land in spite of the swinish game-butchers. . . . All game animals rely upon eyes, ears, and nose to warn them of the approach of danger; but the amount of reliance placed on each sense varies greatly in different species."

The Influence of Sewerage and Water-Supply on the Death-Rate in Cities. By Erwin F. Smith. Pp. 84.

This paper was read at the Sanitary Convention at Ypsilanti, Michigan, July, 1885, and is reprinted from a supplement to the "Annual Report of the Michigan State Board of Health for 1885." As the author himself states, no effort has been made to present anything new in this article, but he has rather sought to place, in a form suitable and convenient for study and comparison, facts and data otherwise not readily accessible. It will seem somewhat surprising at first sight that so much of the material used is from foreign sources; yet this could not be avoided, as the writer forcibly points out, for, although there is no lack of so-called statistics in our own country, yet reliable and therefore valuable mortuary data are obtainable from but few localities. While we can not, in our space, mention all the questions and matters touched upon in this pamphlet, we would call especial attention to the charts appended to it. An examination of them ought to be sufficient to convince the most skeptical as to the direct relation an improvement in the system of sewerage and the water-supply of a city holds to the decrease in the death-rate of its inhabitants from certain diseases.

In Chart I, which records the deaths from typhoid fever to each 10,000 inhabitants before, during, and since the introduction of sewerage and water-supply, Munich, in Germany, shows for the years 1851 to 1859 twenty-one deaths from this disease to each 10,000 inhabitants, while for the period from 1874 to 1884 the rate has fallen to six and three tenths per 10,000.

Another chart, designed to show the protective influence of sewerage and water-supply in the cholera epidemic of 1865–'66, is divided into two groups. The cities enumerated in Group I were abundantly supplied with good water, and in most cases were also well sewered; those in Group II were incompletely sewered, or entirely destitute of modern sewers, and very dirty; their water-supply was scant or open to infection.

In the first group, where we find, among other cities, New York and Brooklyn, the former shows 12·8 deaths per each 10,000 inhabitants, the latter 16·5.

Memphis, Tennessee, which is placed in the second group, shows 268 deaths from cholera per each 10,000 of its population. St. Louis has 173·0 as its record; while Chicago, which in this group makes the best

showing, stands charged with 43·7 for every 10,000 of its inhabitants.

Figures like these themselves furnish an impressive sermon.

The Epic Songs of Russia. By Isabel Florence Hapgood. With an Introductory Note by Professor Francis J. Child. New York: Charles Scribner's Sons. Pp. 359. Price, $2.50.

What are here called "Epic Songs" are really the folk-songs, or songs of the common people, whose only literary existence is in the form of copies taken down from the mouths of some of the singers, after they have been handed down by oral tradition for, it may be, hundreds of years. Besides the pleasure to be got from the works themselves as stories and poetry, the perusal of them, as Professor Child says, is well adapted to help to an appreciation of those of our fellow-men who have been educated by tradition and not by books, and who, though living on the plainest fare of oats, feel and cherish poetry "not less than those who have been nursed in comfort and schooled in literature." These Russian epics possess a striking distinction from those of Western Europe, in that while the latter passed from the popular mouth to writing during the middle ages, and are no longer to be found except in books, the Russian epics are still living in some districts of the country, and are "even extending into fresh fields"; and "it is only within the present century—within the last twenty-five years, in fact—that the discovery has been made that Russia possesses a national literature which is not excelled by the finest of Western Europe." Although one or two small collections had been previously published, which gave, however, no real indication of the richness of the field to be explored, systematic investigation of this literature was first begun by Petr N. Rÿbnikof, of Petrzavodsk, on Lake Onega, about 1860. He discovered the chief minstrel of the region and the most important poem, and succeeded in collecting more than 50,000 verses. A. F. Hilferding, who followed him in 1870, made a still larger collection. "Two of the causes which have aided in the preservation of epic poetry in these remote districts, long after its disappearance from other parts of Russia, are liberty and loneliness. These people have never been subjected to the oppressions of serfdom, and have never lost the ideal of free power celebrated in the ancient rhapsodies." In the isolation of their forests, moreover, they do not come in contact with the world, and have never felt the influence of change—conditions remain as in epic times. They also thoroughly believe the truth of the marvelous things recited in the poems. A curious incident is related, in which the imposition of a new forestry regulation contributed to the extension of the songs. A community were compelled to abandon their farms, and went to net-making. As farmers, they knew nothing of the songs; in company with the net-makers and other handicraftsmen, they learned them all. The singing of the poems is not now a profession, but is a domestic diversion, and the present minstrels all belong to the peasant class, and are nearly all well-to-do. The epic songs proper are divisible into three groups—the cycle of Vladimir or Kiev, that of Novgorod, and that of Moscow—and these are preceded by three songs of the Elder Heroes. In the songs of the Vladimir cycle, the recently Christianized people for convenience' sake baptized their heathen gods, making of Perun, the thunderer, Ilya, or Elijah the Prophet, the hero of the series, and earned the epithet of "two-faithed," which was applied to the Russian people by their older writers. The Novgorod cycle is more restricted, consisting practically of but two songs, and is more definite, more practical, and closer to history than the Kiev cycle. The Moscow cycle begins with Ivan the Terrible and ends with Peter the Great, and is not represented in this volume. A running view of the development of this poetry is given in the author's introduction.

Applied Geology: A Treatise on the Industrial Relations of Geological Structure; and on the Nature, Occurrence, and Uses of Substances derived from Geological Sources. By Samuel G. Williams, Professor of General and Economic Geology in Cornell University. New York: D. Appleton & Co. 1886. Pp. 386. Price, $1.50.

The study of geology may be carried on with two entirely different aims. For one who undertakes the study for the sake of the science itself, the chief interest lies in tracing out from the records of stone a his-

tory of the surface of our globe, in noting the manifold changes which it has undergone, and perhaps, incidentally, studying the flora and fauna that have flourished upon it. Others, however, will regard geology from a different standpoint. Knowledge of the earth's structure, of the location and the occurrence of its various constituents, can be made use of for the interests of man.

A moment's thought of the great number of substances needed by man, for the supply of which he must look to old Mother Earth, will show how closely geological knowledge, applied to this end, is connected with the very progress of the human race. There has been no lack of excellent books devoted to the study of geology as a science, to *theoretical* geology, if this term be permissible. However, the need has long been felt of some work that would serve as an aid in making a knowledge of the earth's structure available for practical purposes. Professor Williams has written his "Applied Geology" to meet this want.

It was a question of no small importance how such a work should be conceived and arranged. On the one hand, it was desirable to have the treatise of value to the student of geological science; on the other hand, the book was to be made available for a large class in the community whose pursuits, although not exactly calling for a training in geology, yet make a thorough knowledge of some features of this science most desirable. In our opinion, the author has been very successful in meeting this twofold purpose.

The first forty-odd pages of this book are given to a consideration of the rock-forming minerals and their classification; to a description of rocks and the arrangement of rock-masses. To one who has already studied geology, these pages will prove a welcome review of certain parts of the science that bear more directly on the subjects to follow; for one who has not before engaged in the study, a careful perusal of this part is essential to an understanding of the sequel. The economic relations of geological structure are then discussed; the important bearing of structure on the relative accessibility of valuable substances and deposits is pointed out; the need of a thorough acquaintance with the obtaining geological conditions, by those undertaking great architectural or engineering structures, is referred to, and so on.

The next chapter is devoted to materials of construction. This embraces a thorough discussion of building-stones, their properties, strength, and durability. Their geological positions and distribution are considered. Some notes on materials for mortars and cements are added.

Then follow chapters on the relations of geology to agriculture and to health. The former takes up the question of the origin of soils, and their composition; of geological fertilizers, of drainage, and subsoils. The latter covers but a few pages and touches on the water-supply of households and communities, and the problems of drainage.

Mineral fuels and geological materials for illumination are taken up in turn. A classification of the coals (with numerous analyses of different kinds) is followed by a review of the geological horizons of mineral fuels; the fuel value of coals, based on their analysis, is explained, and hints are given on the selection of coals adapted to different purposes. The chapter on geological materials for illumination discusses the occurrence of petroleum and the modes of mining and refining this oil.

Next in order comes the consideration of metalliferous deposits. This theme, as is due its importance, occupies a considerable part of the book. Each of the more important ores receives attention in a separate chapter, and the whole forms a most valuable *résumé* of the subject. Tables showing the annual production of many of the leading minerals, compiled from the most recent data, will prove of especial interest to manufacturers. The closing chapters of the book treat of substances adapted to chemical manufacture or use, fictile materials, refractory substances, ornamental stones, and gems.

From all that has been said, an idea may be formed as to the nature and the scope of this work. A book of this kind must naturally rely to a certain extent on the work done by others. The author's task, in great part, has consisted in collecting and collating material from many sources. But from this it must not be inferred that the

work in question is merely a collection of dry facts and data. On the contrary, written by one evidently thoroughly familiar with the ground covered, the book presents in a most interesting manner a vast amount of information of the greatest practical value. The style is clear and concise, and the book will form most pleasant reading, even for one not directly interested in applied geology.

Fifth Annual Report of the United States Geological Survey to the Secretary of the Interior. 1883–'84. By J. W. Powell, Director. Washington: Government Printing-Office. Pp. 469, with Plates and Pocket Map.

The topographic work of the survey has been prosecuted in New England, of which the preparation of a map has been begun, and where the State of Massachusetts is coöperating with the survey; in an area of 19,750 square miles in Western Maryland, West Virginia, Southwest Virginia, Western North Carolina, and Eastern Tennessee; and in various parts of the districts of the Rocky Mountains, the Great Basin, and the Pacific. The geologic work embraces the survey of the Yellowstone National Park, by Mr. Arnold Hague; studies in Dakota and Montana, by Dr. Hayden; of glacial phenomena, by Professor T. C. Chamberlain; of the archæan rocks of Michigan, Wisconsin, Minnesota, and Dakota, by Professor Roland T. Irving; of the Quaternary lakes of the Great Basin, by Mr. G. K. Gilbert; of the Cascade Range, by Captain C. E. Dutton; a survey of the District of Columbia and adjacent territory by Mr. W. J. McGee; economic studies in Colorado, by Mr. S. F. Emmons; and surveys of the Sulphur Bank, Knoxville, and New Idria quicksilver-mining districts, by Mr. G. F. Becker and Dr. W. H. Melville; and of the Eureka District, by Mr. J. S. Curtis. The paleontologic work includes Professor Marsh's labors on vertebrate fossils and those of Dr. C. A. White, Charles C. Walcott, and others, on invertebrates, and the investigations of Mr. Lester F. Ward and Professor Fontaine in fossil plants. Chemical analyses have been carried on by Professor Clarke and Dr. T. M. Chatard, and physical investigations by Carl Barus. Special papers representing a considerable number of these investigations are incorporated in the volume containing the report.

Gyrating Bodies. An Empirical Study. Illustrated by upward of Fifty Figures "from Life." By C. B. Warring, Ph. D. Poughkeepsie, N. Y. Pp. 106. With Three Plates.

A gyrating body is defined as "a body revolving on an axis passing through its center of gravity, and acted upon by a continuous force tending to make it revolve on another axis at right angles to the first." The term includes the top, the gyroscope, several toys to the principle of which these furnish the key, and, according to the author, the earth. Such bodies have some curious and paradoxical properties, which, though they may have been carelessly observed without being remarked upon, will be looked upon as strange when attention is called to them; for they seem to contradict our ideas of the operation of the laws of motion. Mr. Warring's studies cover several instruments of the class, and were prosecuted for the purpose of investigating these properties and explaining them. Having reached an explanation, he finds that similar properties reside in the complicated movements of the earth, and that by them such phenomena as nutation and precession may be accounted for.

American Diplomacy and the Furtherance of Commerce. By Eugene Schuyler. New York: Charles Scribner's Sons. Pp. 469. Price, $2.50.

The author of this work is able to present, in evidence of his understanding of the subject, a record of seventeen years of continuous service in diplomatic positions under our Government, in Russia, Constantinople, England, Rome, Roumania, Greece, and Servia, in all of which stations he has proved himself a useful and efficient agent, and has reflected credit on the American name. The substance of the book is derived from courses of lectures which he delivered last year at Johns Hopkins and Cornell Universities, the purpose of which, in the first series, on our consular and diplomatic service, was to explain the actual workings of the State Department, and to set forth the usefulness and needs of those services to young men who are shortly to be called upon to

perform the duties of citizens; and, in the second series, to show how our diplomacy has been practically useful in furthering our commerce and navigation. Under the former head are the chapters on "The Department of State," "Our Consular System," and "Diplomatic Officials," in which the history, theory, purpose, and operations of those services are fully described; and under the second head is shown "how we asserted our rights to freedom of navigation, freedom from tribute such as was paid to the Barbary pirates, freedom from the police supervision of the ocean which Great Britain at one time wished to obtain, and freedom from the restrictions on the free navigation of rivers and seas, about which we had disputes with powers so remote as Spain, Great Britain, Russia, Denmark, and Brazil." Chapters have also been devoted to the fishery question, and to the efforts of our Government to conclude commercial treaties with foreign powers. The whole subject is a very large one, and Mr. Schuyler calls attention to the fact that several points still remain to be considered.

Dutch Village Communities on the Hudson River. By Irving Elting. Pp. 68. Town Government in Rhode Island. By William E. Foster. Pp. 36. The Narragansett Planters. By Edward Channing. Pp. 23. Pennsylvania Boroughs. By William P. Holcomb. Pp. 51. Baltimore: N. Murray.

These monographs, Nos. 2 and 3 being bound together, form the first four numbers of the fourth series of "Johns Hopkins University Studies in Historical and Political Science." The interest of the studies shows no signs of flagging; there appears to be abundance of material at hand on which to base the successive new researches, and it is well used by the several authors. Concerning the lessons that may be learned from the studies, Mr. Foster remarks, in the opening of his paper, that "the application of the comparative method to the study of early American history has within recent years been attended with results of the most substantial value. The scattered communities along the Atlantic coast which, since 1776, have been united in a common bond of government, had their origin in widely diverse sets of conditions. While, therefore, their development has been characterized by institutions bearing a general analogy to each other, there is sufficient individuality and local differentiation to be observed, in any one instance, to render a somewhat close comparison of their points of resemblance and difference extremely serviceable. It is plain, moreover, that the further down in the scale of local division we can go, the more fruitful will be the study of these local institutions."

Mr. Elting's paper, on "Dutch Village Communities on the Hudson River," shows how these communities, which were in fact a secondary though more natural form of organization supplementing the first artificial and unsatisfactory aristocratic form, were really the outgrowth of German institutions that are known to have existed at least as far back as the time of Julius Cæsar. The same idea of community in the ownership of the land appears to mark them both. In conclusion, the author asserts, with considerable boldness, we think, that "from the banks of the Rhine, the germs of free local institutions, borne on the tide of Western emigration, found here, along the Hudson, a more fruitful soil than New England afforded for the growth of these forms of municipal, State, and national government, which have made the United States the leading republic among the nations."

Mr. Foster, in his "Town Government in Rhode Island," dwells upon the independent origin and independent action of the towns, which prevented them from associating themselves together except under great stress of circumstances, and then under reservations which fixed a stamp on the character of the State; and this trait of original organization explains the hesitation which was shown by Rhode Island in adopting the Federal Constitution. In the "Narragansett Planters," Mr. Channing describes a peculiar landed aristocracy possessing large estates, who, obtaining a holding on Narragansett Bay, produced a state of society which had no parallel in New England, and "was an anomaly in the institutional history of Rhode Island."

In "Pennsylvania Boroughs," Mr. Holcomb glances at the antiquity of the borough in England, considers the meaning of the term, especially as used in Pennsylvania, in

distinction from "town," studies early borough government in Germantown as the first borough organized in the State, and in Bristol as a type of the boroughs of the eighteenth century, and examines the character and the possibilities of the present borough.

Proceedings of the American Society of Microscopists. Eighth Annual Meeting, 1885. Pp. 258. Price, $2.

Among the numerous essays printed in this volume—many of which will undoubtedly prove enjoyable reading for the specialist—are a few which will claim the interest of a wider circle.

"The Cultivation of Bacteria, and the Cholera Bacillus," by Lester Curtis, treats of the mode of growth and development of this peculiar bacillus that has of late created such a stir and commotion in the learned world abroad. The differences between the bacillus of Koch and that of Finkler-Prior, with which it was by some considered identical, are clearly pointed out. To the author, "the proof that this bacillus is unlike any other form, and is peculiar to cholera, seems conclusive." And further on he states, "That it is the cause of the disease seems to me scarcely less so."

Considerable comfort will be derived from the statement that cholera is a disease not contagious as small-pox and measles are; it is only caused by the bacillus gaining entrance to the intestinal canal, and can therefore, by simple precautions, be readily guarded against. Moreover, the germ is easily destroyed; exposure to superheated steam for half an hour or so will, it is claimed, cause its death. Cold will retard the development of these organisms, but does not kill them.

An article on "Poisonous Dried Beef," by H. J. Ditmers, seeks to ascribe to the presence of certain micrococci, of which a great number were found in the meat examined, the sickness caused by its consumption. That is to say, to these micrococci is ascribed the formation of the poisonous principle present.

From the fact that nearly all pathogenic bacteria are powerless to cause harm unless conditions suitable for their development are offered by the animal organism, the writer further infers that the beef in question was the flesh of some animal or animals that were in a dying, or else in a highly frenzied, condition when slaughtered. That the meat of an animal in such a condition is sometimes—not always—very poisonous, is a matter of record, and meat obtained from such a source should be condemned as unfit for food.

Studies in General History. By Mary D. Sheldon, formerly Professor of History in Wellesley College and Teacher of History in Oswego Normal School, New York. Students' Edition. Boston: D. C. Heath & Co. 1885. Pp. 556. $1.60.

This text-book is not designed for children, but for pupils well on in their teens and twenties. It is an attempt to apply what is known as the "Objective Method" of teaching science to the study of history. To this end, instead of memorizing the conclusions of others, the pupil is put in such relations to the data of history that he will draw his own conclusions. Temples, walls, aqueducts, pyramids, men have built; countries they have conquered, settled, abandoned; their laws, arts, literature, amusements, their heroes, enemies, gods, are the sort of "historical realities presented, with accompanying pictures, maps, stories, quotations, and facts. Questions and problems, such as will compel thought upon these data and their relations, are an important part of this unique plan of converting one of the last strongholds of rote-learning into a training of the reflective faculties."

Second Report on the Injurious and other Insects of the State of New York. By J. A. Lintner, State Entomologist. Albany: Weed, Parsons & Co. Pp. 265.

The present publication presents mainly studies and observations that were made in the years 1882 and 1883, with a few of a later date. The insect depredations during these two years were less than for the preceding year, and no formidable new pest was remarked as threatening any principal crops. The years, of late, the report adds, in which such additions have not been made, are unfortunately exceptional ones. The zebra-caterpillar was unusually destructive on mangold-beets. While the grass-lands were relieved from the Vagabond Crambus which had visited them in 1881,

and the corn-worm was absent, the clover-seed midge has covered a more extensive territory, although its ravages do not appear to be increasing where it has been abundant, and the punctured clover-leaf weevil has steadily and rapidly extended its area of operations. The Colorado potato-beetle seems to be diminishing. The chinch-bug was remarked for the first time in injurious numbers in the State of New York. The substance of the report consists chiefly of full descriptions of the injurious species of insects, accompanied by as many illustrations as the State printers found it convenient to insert. On this subject, Dr. Lintner well remarks that many years must elapse before good figures of any of our common and more destructive insect pests can be repeated so often that a general familiarity with them and the species that they represent in nature shall render their further repetition useless.

PUBLICATIONS RECEIVED.

Aliette. By Octave Feuillet. Translated from the French by J. Henry Hager. New York: D. Appleton & Co. 1886. Pp. 250. 50 cents.

On the Chemical Behavior of Iron in the Magnetic Field. By E. L. Nichols. Pp. 13.

The Germ-Theory. By J. B. Olcott, South Manchester, Conn. Pp. 41.

The Descent of Man. Office of the "Standard," 9 Spruce Street, New York. Pp. 48. 10 cents.

United States Government Publications. Monthly Catalogue. Vol. I, No. 12. December, 1885. Washington: J. H. Hickcox. Pp. 48. $2 per annum.

Industrial Education in our Common Schools. By H. H. Dinwiddie, Fort Worth, Texas. Pp. 16.

"Texas Review." C. R. Johns and S. G. Sneed, editors. Austin, Tex.: C. R. Johns & Sons. March, 1886. Pp. 80. $3 a year; 25 cents a single number.

Outlines for a Museum of Anatomy, prepared for the Bureau of Education. By R. W. Shufeldt. Washington: Government Printing-Office. Pp. 65.

The Manufacture, etc., of Iron, Steel, and Coal, in the Dominion of Canada. By James H. Bartlett. Montreal: Dawson Brothers. Pp. 167.

The Influence of Emerson. By William R. Thayer. Boston: Cupples, Upham, & Co. Pp. 30. 25 cents.

American Historical Association. Report of Proceedings of the Second Annual Meeting, at Saratoga, September, 1885. By Herbert B. Adams. New York: G. P. Putnam's Sons. Pp. 73. 50 cents.

Insects affecting the Orange. By H. G. Hubbard. Washington: Government Printing-Office. Pp. 220, with Plates.

Watkins's "Advertisers' Gazette." Prospect, O.: R. L. Watkins, Newspaper Advertising Bureau. Pp. 102.

Report of the Hydrographer of the Bureau of Navigation to June 30, 1885. Washington: Government Printing-Office. Pp. 41, with Plates and Charts.

The Irish in America. By William R. Grace. Chicago: McDonnell Brothers. Pp. 31.

Ninth Report of the State Board of Health of Wisconsin, 1885. Madison, Wis.: Democrat Printing Company. Pp. 308.

New York Agricultural Experiment Station, Bulletin No. 8. Geneva, N. Y. E. Lewis Sturtevant, Director. Pp. 2.

Department of Agriculture, Alabama. Bulletin No. 7. E. C. Betts, Commissioner. Pp. 24.

The Museums in the Park, why they should be open on Sunday. New York: The "Truth-Seeker" Company. Pp. 32.

The Craters of Mokuaweoweo, on Mauna Loa. Surveyed by J. M. Alexander. October, 1885. Pp. 6.

Accurate Mountain Heights. Pp. 5. Observations of Variable Stars in 1885. Pp. 16. A New Form of Polarimeter. Pp. 10. Atmospheric Refraction. Pp. 24. By Edward C. Pickering, Harvard Observatory.

The Annual River and Harbor Fraud. By Henry Francis Knapp, 135 Pearl Street, New York. Pp. 4.

A Plea for Impartial Taxation. Addresses by S. B. Duryea, T. B. Wakeman, and G. R. Hawes. New York: The "Truth-Seeker" Company. Pp. 38.

Common Sense applied to Disease and its Treatment. By F. J. McKenzie, Oshkosh, Wis. Pp. 8.

Topographic Surveys of States. By H. F. Walling. New York: D. Van Nostrand. Pp. 10.

The Etiology, Morbid Anatomy, Varieties, and Treatment of Club-Foot. By A. Sydney Roberts, M. D. Philadelphia: P. Blakiston, Son, & Co. Pp. 32.

Annual Address of C. V. Riley, President of the Entomological Society of Washington. Pp. 10.

The Mildews of the Grape-Vine. By Dr. C. V. Riley. Five-column sheet.

On the Conditions that determine the Length of the Spectrum. By Amos E. Dolbear, College Hill, Mass. Pp. 2.

The Mind-Cure. By Eldridge C. Price, M. D., New York. Pp. 32.

Primary Phenomenal Astronomy. By F. H. Bailey, Northville, Mich. Pp. 97.

The Mark of Cain. By Andrew Lang. New York: Charles Scribner's Sons. Pp. 173. 25 cents.

Cremation of Human Bodies not a Necessary Sanitary Measure. By Frank H. Hamilton, M. D. Pp. 11.

The Requisite and Qualifying Conditions of Artesian Wells. By Thomas C. Chamberlain. Washington: Government Printing-Office. Pp. 50.

Notes on Maya and Mexican Manuscripts. By Cyrus Thomas. Washington: Government Printing-Office Pp. 65.

Tales of Eccentric Life. By William A. Hammond and Clara Lanza. New York: D. Appleton & Co. Pp. 209. 25 cents.

For Maimie's Sake. By Grant Allen. New York: D. Appleton & Co. Pp. 232. 25 cents.

Life and Adventures of Baron Trenck. New York: Cassell & Co. Two vols. Pp. 192 and 191. 10 cents each.

War and Peace: the Invasion. By Count Leo Tolstoi. New York: W. S. Gottsberger. Two vols. Pp. 321 and 270.

Kant's Ethics. A Critical Exposition. By Noah Porter. Chicago: S. C. Griggs & Co. Pp. 249. $1.25.

Flowers, Fruits, and Leaves. By Sir John Lubbock. London and New York: Macmillan & Co. Pp. 147. $1.25.

Hand-Book of Plant Dissection. By J. C. Arthur, C. R. Barnes, and J. M. Coulter. New York: Henry Holt & Co. Pp. 256. $1.50.

A Manual of Mechanics. By T. M. Goodeve. New York: D. Appleton & Co. Pp. 227.

Unwise Laws. By Lewis H. Blair. New York: G. P. Putnam's Sons. Pp. 178.

Scriptures, Hebrew and Christian, arranged and edited for Young Readers. By Edward T. Bartlett and John P. Peters. New York: G. P. Putnam's Sons. Pp. 545. $1.50.

Report of the Smithsonian Institution for 1884. Washington: Government Printing-Office. Pp. 904.

Class-Book of Geology. By Archibald Geikie. London and New York: Macmillan & Co. Pp. 516. $2.60.

Persia. By James Bassett. New York: Charles Scribner's Sons. Pp. 343. $1.50.

Labor, Land, and Law. By William A. Phillips. New York: Charles Scribner's Sons. Pp. 471. $2.50.

Terminal Facilities for handling Freight of the Railroads entering the Port of New York. By Gratz Mordecai. New York: "Railroad Gazette." Pp. 68, with Maps.

The Country Banker. By George Rae. New York: Charles Scribner's Sons. Pp. 320. $1.50.

Triumphant Democracy. By Andrew Carnegie. New York: Charles Scribner's Sons. Pp. 519. $2.

History of the Pacific States of North America. California. Vol. IV. By Hubert Howe Bancroft. San Francisco: A. L. Bancroft & Co. Pp. 786. $5.

Essays on Educational Reformers. By Robert Herbert Quick. Syracuse, N. Y.: C. W. Bardeen. Pp. 330. $1.50.

What is Theosophy? By a Fellow of the Theosophical Society. Boston: Cupples, Upham, & Co. Pp. 28. 50 cents.

California, from the Conquest in 1846 to the Second Vigilance Committee in San Francisco. By Josiah Royce. Boston and New York: Houghton, Mifflin, & Co. Pp. 513. $1.25.

POPULAR MISCELLANY.

How the Oyster makes his Shell.—Professor Samuel Lockwood, in a recent lecture before the New York Microscopic Society, answered the question which is asked by the fool in "King Lear"—"Canst thou tell how an oyster makes his shell?" He starts with the hinge-end, at the spot known to conchologists as the *umbo*. "A small plate, or single scale, now represents each valve, and that is the first season's growth. The next season a new growth, or plate, shoots out from underneath the first one, just as shingles do. The oystermen call these laps, or plates, 'shoots,' and they claim that the number of shoots indicates the years of the oyster. They certainly do contain a record of the seasons, showing the slow-growing and the fast-growing seasons. . . . I have likened these shoots to shingles. Now, at the gable of a house the shingles may be seen edgewise. So on the side of an oyster-shell is a series of lines. This is the edgewise view of the shoots, or season-growths. Another factor is the purple spot, or scar, in the interior of the shell. It is the place of attachment of the adductor muscle. Its first place of attachment was close up to the hinge. Had it stayed there until the shell had become adult, how difficult would be the task of pulling the valves together!—the leverage to be overcome would be so great; for we must bear in mind the fact that at the hinge-end the valves are held by this black ligament, which is, in life, elastic, swelling when the shell opens, and being compressed when the animal draws the valves together. So, with every year's growth, or elongation of the shell, the mollusk moves the place of attachment of the muscle onward, that is, in advance farther from the hinge. As it does so, it covers up with white nacre all the scars that are back of the one in actual use as the point of attachment of the muscle." To make the similitude of the oyster's shoots, or season-growths, with the shingles on a roof complete, "it would be necessary for the bottom shingle on the roof to underlie the whole series, and reach even to the roof-tree, or ridge-pole. Then the second shingle from the gutter must in like manner underlie all the rest of the series; so of the third, and so on with the rest. In this way lie the shoots, or laps, of the oyster's shell. The last one deposited underlies them all, and every one terminates at the channel in the bill—so that this groove in the bill contains a series of transverse lines, each one marking a season, or a year. Thus we get really four factors for the solution of the question, 'How old is the oyster?' all of which are the outcome of the method or way of making the shell."

The Trap-Dike of Southeastern Pennsylvania.—Professor H. D. Rogers, in his report for 1858 on the geology of Pennsylvania, refers to two trap-dikes in the southeastern part of the State. In the map published in connection with Professor J. P. Lesley's survey, Mr. C. F. Hall connects the two dikes so as to make a single dike about eight miles long. Professor H. Carvill Lewis, after two years of observations, has found that this dike is only a small part of a long, narrow dike, which passes almost entirely across the southeastern part of

Pennsylvania, from near Doylestown to Maryland, and which, taken together with some parallel dikes of similar nature and composition, northeast of Doylestown, forms a series of nearly continuous dikes some ninety miles in length. In the paper he has published on the subject he shows that, although frequently represented only by a line of loose weathered bowlders, it is practically continuous along a course seventy miles in length. In Bucks County the dike abuts against the south side of a great fault of several thousand feet upthrow, and upward of twenty miles in length, while, at a distance laterally of five miles, another long dike of identical composition and structure abuts against the north side of the fault, and continues thence to the Delaware River. If not the same dike laterally displaced, the two portions clearly belong to the same system, and were produced by a single cause. It is said that this dike was used during the war of the rebellion by the negro slaves as a guide in their flight northward. Several of the stations of the underground railroad are said to have been on or near its line; and the negroes were directed to follow these black rocks across fields and through woods "until they were led into the hospitable regions of Chester and Bucks Counties."

The Magnitude of Dr. Gould's Astronomical Work.—At the complimentary dinner given to Dr. B. A. Gould in Boston, in May, 1885, Professor W. A. Rogers, of Harvard Observatory, made a suggestive comparison of the work which Dr. Gould has done at Cordoba, in the Argentine Republic, with similar work done previous to 1872. There are, he said, in the northern heavens about 4,500 stars visible to the naked eye; while within the same limits there are about 95,000 stars as bright as, or brighter than, the ninth magnitude, which are usually observed in narrow belts or zones, and are referred to as zone-stars. The bright stars are common to nearly all general catalogues, but the positions of the fainter stars depend, for the most part, on two or three separate observations. Dr. Gould has formed two catalogues since 1872—a general catalogue of stars extending to the south pole, containing 34,000 stars, and a catalogue of zone-stars, numbering 73,000. The two catalogues represent about 250,000 separate observations. It is stated in one of the printed volumes that the chronographic register of the transits, the pointing of the telescope for declination, have all been done by Dr. Gould personally. The number of distinct and separate observations involved in this work must certainly exceed a million. The whole number of stars in the two Cordoba catalogues is nearly three times as great as in any single catalogue thus far constructed; and it must be remembered in this connection, that the great catalogues of Lalande, of Bessel, of Argelander, and of Schjellerup, represent the labors of a lifetime. The total number of stars in all catalogues formed previous to 1870 is about 260,000, as against the 105,000 stars in the Cordoba catalogues. Since 1869, a confederation of fourteen observatories, situated in different parts of the world, has been engaged in the accurate determinations of the positions of the 100,000 stars to the ninth magnitude in the northern heavens. Up to 1882, a total of about 346,000 observations had been made. Considerable progress had been made in this work before Dr. Gould left this country for South America. His work, involving two thirds as many observations as all others combined, is completed, and is all in the hands of the printer, while the actual formation of the catalogue to be issued under the direction of the *Astronomische Gesellschaft* can hardly be said to have been begun.

Japanese Camphor.—Camphor is very largely exported from the Japanese island of Kiu Shiu, where the tree grows abundantly in all situations. Many of the trees reach a great size, some near Nagasaki being said to be ten or twelve feet in diameter, while at other places are trees measuring twenty feet across; after forming a trunk twenty or thirty feet high without limbs, the tree branches out in all directions, forming a well-proportioned and beautiful evergreen mass. The leaf is small, elliptical, slightly serrated, and of a vivid dark green. The berry grows in clusters, and resembles a black currant. The wood is valuable for cabinet-work and for pur-

poses of ship-building. The tree is necessarily destroyed in the manufacture of camphor, but the law requires a new one to be planted in the place of every one taken away. The gum is extracted by distillation from the chips, the whole tree being cut up for the purpose, and steamed in a tight vessel or box. The steam, camphor, and oil, the immediate products of the process, are conducted through a bamboo tube to a second tub, and from this to a third, which is divided into an upper and a lower compartment. The partition between the two divisions is perforated with small holes to allow the oil and water to pass to the lower compartment. The upper compartment is supplied with a layer of straw, which catches and holds the camphor in crystals. The camphor is then separated from the straw and packed in wooden tubs containing a *picul*, or one hundred and thirty-three and one third pounds, each, for the market. The oil is used for illuminating and other purposes. The exports of camphor from Nagasaki in 1882 were valued at $290,000.

Protect the Birds.—The Committee on Protection of Birds of the American Ornithologists' Union has begun the issue of circulars, calling attention to the threatened danger of the destruction of our native birds by the greed of specimen-collectors, milliners, egg-hunters, and Vandal sportsmen. A paper by Mr. J. A. Allen, in the first "Bulletin," gives an estimate of the alarming extent to which this destruction is going on. The conditions of modern life are in themselves furnishing what we might now call natural agencies—that is, spontaneous and of constant operation—which contribute more, perhaps, than all previously operating natural agencies combined to limit the increase, or, perhaps, diminish the numbers, of birds. To these may be added the growth of a passion for hunting birds for various purposes and sometimes under mistaken views, which has become so violent that it is almost a wonder that any birds are left. Collectors appear to be charged with a larger share of responsibility in this matter than—notwithstanding there is vastly too much reckless collecting—they deserve. Mr. Allen calculates that the number of birds killed for their purposes since collecting began does not exceed 500,000; while, to gratify the vanity of the "dead-bird-wearing gender" of the human race, not less than 5,000,000 are sacrificed every year! Mr. George B. Sennett, in a paper in which he tells how the pelicans were exterminated from an island off the coast of Texas in an experiment at making an oil from them which proved to be worthless, says that "if a tithe of the truth were known throughout the country at large concerning the sacrifice of bird-life in the names of 'business,' 'enterprise,' 'food,' 'sport,' and what not, from Maine to Mexico, and from California to Alaska, there would be such a cry of remonstrance as would make the bird-destroyers hang their heads for shame"—that is, if there is any shame left in persons capable of engaging in such business. By far the largest numbers of birds are slaughtered to supply ladies' hats; and it is for the ladies themselves to apply the remedy for the evil, by refusing to wear such barbaric ornaments. Noble women in this and other countries are organizing to put down the iniquitous fashion. The object deserves universal support.

Professor Pickering's Telephone.—In a paper read by him before the American Academy of Arts and Sciences, on his "Early Experiments in telegraphing Sound," Professor Edward C. Pickering showed that in 1870, several years before the telephones now in use were invented, a receiver was devised, constructed, and tried, which consisted of a flexible iron diaphragm, supported at the edges and replacing the armature of an electro-magnet. Musical sounds were telegraphed successfully, and the apparatus was described at a scientific meeting, of which a report was published in the "Troy Press" of August 24, 1870. In 1872 and later, the experiment was repeated under various conditions. In 1879 it was shown that the instrument was capable of serving as a telephone, and of rendering articulate speech audible at a distance. It appeared to differ in no way in principle from the receiver now used. Professor Pickering explains, however, that all his experiments were made, or were intended to be made, with

a discontinuous current, and, although the instrument is capable of showing the variations of a continuous current, the author did not have this application in mind when he constructed it. No patent was taken out for the device, for the inventor believed that "a scientific man should place no restrictions upon his work which would tend to prevent the repetition of an experiment of scientific interest. A full description should have been published. This was at first delayed, from the pressure of other work, and lack of appreciation of the importance of the results. Afterward I was unwilling to enter into a controversy, or to obstruct my friends, who were struggling to obtain proper recognition of the great results they had obtained in the same field."

What Ice can do.—The important part in producing or modifying topography that has hitherto been conceded to moving masses of ice has recently been disputed by some American geologists, who have denied that ice possesses any eroding or excavating power. Professor J. S. Newberry has published an article sustaining the old theory against these contradictions by evidences drawn from the visible action of living glaciers, as in the Alps, and also in the mountains of Oregon, where a remarkable monotony of surface has been produced by ice-action. The crest of the Cascades, crowned by the volcanic peaks, Mount Jefferson, Mount Hood, etc., has sides sloping east and west, like the roof of a house. These slopes are planed down, and their asperities removed, everywhere showing the effects of a powerful grinding agent. In the Laurentian belt north of the lakes, where were formerly high mountains, are now only low hills and rolling surfaces, and the strata are "standing at high angles but planed down, scratched and ground by glaciers, until their cut edges are like boards in a floor." Similar work has been performed between the Hudson and the Connecticut. The action of running water on topography is not only different from that of ice, but antagonistic to it. Water deepens the lines of drainage and increases the asperities. The cañons of the Colorado are typical and characteristic illustrations of water-action on continental surfaces. Great ice-sheets, on the contrary, tend to reduce all asperities, fill depressions, and render the topography monotonous. If ice is competent to do the work of shaving and smoothing the landscape, which the author aims to prove by his citations that it has done, much more may it have excavated lake-basins. "The power which has done the greater is certainly equal to the less." Probably, Professor Newberry adds, some misapprehension arises from an inadequate conception of the composition and action of a glacier. "It is, perhaps, regarded as a mass of pure ice, which by itself would have little grinding power; but a glacier is a great moving mass which by its weight and motion crushes and removes all but the most solid rock prominences over which it passes. Where it impinges against cliffs, these are sometimes lifted, and huge blocks are carried away. In many localities we find stones hundreds of tons in weight, which have been torn from their beds and carried many miles. Pure ice, then, in sufficient volume is a potent and almost irresistible agent of erosion, quite independent of its grinding action; but, as a matter of fact, all glaciers are studded below with rock-fragments, great or small, which they have torn up in their course; so that sand, gravel, and bowlders constitute a coating to the under surface of a glacier which may be compared with the emery on a copper wheel."

Have we gone too far in draining Swamps?—In one of a series of papers on "The Proper Value and Management of Government Timber-Lands," read at the Department of Agriculture, in May last, Mr. M. C. Read showed that harm rather than good has been done by the draining of the swamps which has been so vigorously prosecuted during the last twenty-five years. The swamps were constant store-beds and sources of moisture, and tended to keep the streams that drew upon them at an even level. In draining them, they being generally found on the same level as the surface of adjacent lakes, the outlets of the lakes were deepened so that they could be drained more speedily and completely. To accommodate the more rapid outflow that accrued, the streams below were often straightened and cleared out, and the rapid concentration of the water into the larger streams was

made as easy as possible. "All three agencies combined are making the surface-drainage almost as perfect as if a series of impervious roofs covered the land, and all the flow from them were conducted by pipes into one common channel." Consequently, "springs once copious have disappeared; streams formerly perennial alternately overflow their banks and run dry. The natural regulators of the streams having been destroyed, whenever there is an excessive rain it is rapidly carried into the streams, which, gradually uniting their waters, often constitute floods in larger channels which no human appliances can control." Dikes and levees will check the evil for a time, only to make it greater in the future. The only possible remedy for all these evils is "to hasten as quickly as possible to undo our work and recreate the natural reservoirs we have destroyed. By reforesting the swamps and the higher land which surrounds them and the lakes, "we shall restore them to their proper place in the economy of Nature." The lakes should be restored to their former dimensions, and enlarged wherever practicable. A scheme kindred to this is that of creating artificial reservoirs at the sources of rivers, as at the sources of the Ohio in the Alleghany Mountains, by damming up the ravines of the smaller streams.

Earth-Contraction and Mountains.—Mr. William B. Taylor lately read a paper before the Philosophical Society of Washington before which he suggested that the crumpling of the earth's crust, with the formation of mountain-ranges, was a result of modification in the spheroidity of the globe produced by a change in the length of the day, which change is an effect of the retarding action of the tides. It is established, in the author's mind, as beyond a reasonable doubt, that our present day is considerably longer than the day of early geological times. Supposing the equatorial radius of the earth to have been once one tenth greater and the polar radius one tenth less than they are now, it is evident that, from the very slow but never-ceasing contraction of the equatorial shell, due to diminution of rotatory motion, "this crust would be subject to an unremitting stress of lateral compression as relentless as that from the old hypothetic shrinkage of volume by reduction of temperature. Is it not precisely this *morphologic* contraction whose effects and records are everywhere apparent in the crumpling of the earth's crust?" On this view the facts may be explained that the circumpolar regions, where the crust has, by the theory, been stretched, are relatively free from mountains or plications, while the intertropical region contains the highest elevations. So strongly impressed is Mr. Taylor "with the inevitable operation and potency of this unquestioned retardation of rotation that, were all traces of any differential action masked and obliterated, he would still hold to it as the one efficient cause to account for the prominent constriction of the crust displayed in every land. But the differential traces of oblateness have not been obliterated—masked though they may be, to some extent, by other perturbations." From various conditions, he adds, "we may infer that in all geological ages the progress of elevation has been in excess of that of degradation by erosion; that in all ages mountain-building has been at a maximum; that is, that the uplifted heights have been the greatest which the average thickness of the crust at the time was capable of supporting; so that the former has been a constant function of the latter, the ratio being probably not far from one fifth." The increasing maximum of elevation has probably now reached its limit, for both the processes of equatorial contraction and of internal temperature reduction are going on with extreme and lengthening slowness; "and the whole remaining subsidence of the intertropical oblateness can not exceed five miles, during the vast ages in which the earth's rotation shall be entirely arrested."

Snake-Poisoning.—Dr. G. C. Roy, contrasting the physiological action of snake-poison and the symptoms of rabies, has made the suggestion that the venom of the cobra might be tried to counteract the morbid phenomena of rabies. An interesting compendium of facts respecting snake-poisons has been published in Calcutta by Mr. Vincent Richards, from which we learn, among other things, that we have no antidote to the poison when it has once fully entered into the system. If the venom can

be confined to a part, by means of a ligature, then permanganate of potash, in a five per cent solution, is an efficient destroyer of its power. Ammonia is not a remedy. Some seeming cures may be accounted for by the fact that, if an insufficient dose of the venom be administered, the bitten animal will live, whether stimulants—alcohol or ammonia—be given or not. The intellect does not appear to be affected by snake-poisoning, but remains unclouded to the last.

Turquoises.—The turquoise, in the middle ages, was accredited with even more supernatural virtues than were ascribed to other precious stones. The wearer of it had his sight strengthened and his spirits cheered; if he fell, the gem would break instead of his bones, and save them; and, if he became sick, it turned pale. When its possessor died, it lost its color, to recover it again on passing into the hands of another. In some mysterious way, when suspended by a string, it was capable of correctly striking the hours on the inside of a glass vessel. Turquoise—a hydrated phosphate of alumina colored by traces of compounds of copper and iron—may be of various colors of blue and green, but only the fast sky-blue specimens are prized as precious stones. The other shades may be imitated in inferior stones, this one not. The material of some fossil teeth is capable of being colored with phosphate of iron so as to resemble real turquoise, when it is called odontolite or Occidental turquoise, but it is softer than the genuine Oriental stone, and thereby easily distinguishable from it. Jewelers' turquoises come from the mountains of Khorassan in Persia. A very satisfactory report upon the mines has been furnished the British Foreign Office by Mr. A. H. Schindler, who was for a short time director of them. The veins occur in the metamorphic strata, with which the nummulitic limestone of the mountains is mottled, and are very ancient and extensive, bearing frequent evidences of the old workings. The mines are quite deep, one of them reaching down to one hundred and sixty feet. The works are carried on by the people of the villages, who are careless in management, and improvident. At the mines, the turquoises are roughly divided into three classes, of first, second, and third qualities. All the stones of good and fast color and favorable shape belong to the first class. But they vary most curiously in value, for Mr. Schindler says, "it is impossible to fix any price, or classify them according to different qualities. I have not yet seen two stones alike. A stone two thirds of an inch in length, two fifths of an inch in width, and about half an inch in thickness, cut *peikâni* (conical) shape, was valued at Meshed at three hundred pounds; another, of about the same size, shape, and cut, was valued at only eighty pounds. The color most prized is the deep blue of the sky. A small speck of lighter color, which only connoisseurs can distinguish, or an almost unappreciable tinge of green, decreases the value considerably. Then there is that undefinable property of a good turquoise, the *zât*, something like the 'water' of a diamond or the luster of a pearl; a fine colored turquoise without the *zât* is not worth much." The stones are cut in three ways—the flat or slightly convex form, the truncated cone, and the tallow-drop or *en cabochon*. The higher the conical and convex surfaces in the two latter, the more the turquoises are prized. None but a fine, deep-colored stone can be advantageously cut into a conical shape, since one of a pale color would appear almost white at the apex. Some mines contain stones which look well at first, but soon change their color and fade. These, of course, are worthless.

Poisons formed from Food.—The subject of "Poisons formed from Food, and their Relation to Biliousness and Diarrhœa," has been considered by Dr. T. Lauder Brunton in articles in "The Practitioner." There are persons, he says, or even, perhaps, "classes of people," to whom even articles of food, usually salutary, are poisonous. Many articles of food, also, have a property of splitting themselves up so as to yield poisons. The melon and cucumber tribe of vegetables exhibits a tendency to the formation of purgative substances. In animal foods poisonous properties are apt to appear either from particular modes of cooking, or from beginning decomposition. The decom-

position may be effected by microbic organisms, or by the digestive ferments of the healthy body; and they are various according to the particular organism or ferment that sets them up, and according to the temperature at which they occur, and the length of time that they continue. Some of the products of decomposition are poisonous in various degrees of activity, while others are innocuous. When kept separate, the poisonous products remain unchanged for a long time, but when mixed together they are apt to undergo further decomposition and become inert. Besides temperature, the degree of moisture in the subject of decomposition or in the atmosphere, and electrical conditions—as when milk is "soured by thunder"—exercise modifying influences, which have not yet been definitely ascertained. The difference between the products of decomposition in hot and cold weather is illustrated by the alkaloids obtained from decomposing maize in summer and winter. The winter alkaloid has a narcotic and paralyzing action; but in summer another alkaloid is also yielded, which has a tetanizing action something like strychnine. On account of the greater rapidity of the putrefactive process, albuminous substances become poisonous much sooner in summer than in winter, and again lose their poisonous properties more quickly by further decomposition. As putrefaction may go on to a certain extent after the introduction of food into the intestinal canal, poisons may be formed from the part eaten, and produce dangerous symptoms, while no poison can be found in the remaining parts of the same food.

The Hypothetical Planet Neith.—Seven times since the invention of the telescope a lesser body has been observed near Venus in such a situation as to suggest that it might be a satellite of that planet. The observations can hardly have been illusive, though they were only fleeting ones, for they were made by skilled astronomers. The last one was in 1764. M. J. C. Houzeau, of the Brussels Observatory, has examined the data of them in an endeavor to determine the nature of the body. They do not agree with the supposition that it is a satellite, or that it is an intra-Mercurial planet. They are consistent, however, with the supposition that it moves in an orbit about equal to or a little larger than that of Venus, with which it comes in conjunction at intervals which are multiples of a little less than three years; for the intervals between the observations all represented such multiples. Supposing the observations to be correct and to indicate the real existence of such a body, M. Houzeau proposes for it the name of Neith. The search for this planet would furnish good occupation for amateur astronomers.

Causes of Financial Stringency.—The "Edinburgh Review" ascribes the present general monetary scarcity to the vast expansion of trade since the middle of the century, which was in great part an effect as well as an accompaniment of the new supply of gold that came in at that time; the decline which has taken place in the yield of the gold-mines; and the large augmentation in the demand for gold which has been occasioned by the extensive demonetization of silver. The influence which the large addition to the world's stock of specie since 1848 has exerted upon the value of money, though important, has been by no means so great as was expected. "The doctrine that changes in the amount of the circulating medium are really of no consequence, inasmuch as such an increase is *pari passu* attended by a proportionate change in the value of money, so that the effective power of the currency remains unaltered, is now all but extinct, and can survive only in minds which are impervious to the remarkable lessons of the last thirty years," which have "demonstrated afresh the correctness of the old and common-sense view of the matter—namely, that if there is an increase of business operations, or other effective requirements for money, a proportionate addition to the currency will only serve to keep the value of money at its previous level; and, if trade or these monetary requirements increase faster than the amount of currency, prices will fall (or the value of money will rise), however large the annual additions to the currency may be. More remarkably, and on a far grander scale, the same truth or principle was illustrated in the history of the three centuries which followed the discovery of

the New World." In 1850 sixteen millions sterling of specie annually did less for the wants of the world than ten millions had done in 1810, and much less than two millions had done nearly three centuries previously, in the reign of Queen Elizabeth. "Whenever the supply of money becomes stationary in the civilized world, or in a progressive community, prices begin to fall, owing to the steady increase of population and monetary requirements. Thus, . . . during the silver age, although the annual production of the precious metals increased continuously throughout three hundred years—well-nigh doubling in each successive century—the monetary wants of the world increased quite as fast, and ere long began to outstrip the growth of the monetary supply." A careful analysis of the statistics of coinage and other uses, and of the supply of the precious metals, based upon the reports of the Director of the United States Mint, shows that "the current requirements for coinage of themselves exceed the total annual supply of the precious metals by four millions sterling, while the consumption in the arts amounts to nineteen millions—indicating a reduction, or at least an inadequate supply, of metallic money to the extent of twenty-three millions annually." The disastrous effects of a monetary dearth are extensive. It affects not only current trade, but real property, or fixed wealth of all kinds. The value of money is rising, and consequently the sale value of all other commodities is falling. Even the moneyed class lose also, owing to the low rate of interest and the lack of remunerative kinds of investment; but agriculture is most affected by a change in the value of the circulating medium, because such a change comes upon it with direct and unbroken force. Thus, the mischief works round the whole community, or indeed the civilized world. No human power can prevent the embarrassment arising from an inadequate production of the precious metals. "But, fortunately, the source of our present difficulties is no longer the mystery that it was, even to statesmen, in former times. The fact that nowadays it can be traced to its fundamental causes constitutes the best hope amid our present difficulties."

Is Tea-drinking salutary?—The Dean of Bangor has charged tea-drinking with destroying the calmness of the nerves, making people uneasy and irritable, and acting as a dangerous revolutionary force. Some medical men, including American doctors and Dr. Richardson, agree with him; but Dr. Gordon Stables has pronounced tea "the drink of pleasure and health," and has expressed the opinion that it ought to be the national drink of England. The general current of public opinion and practice appears to be favorable to the latter view. In the British army, says the "Pall Mall Gazette," the use of tea is slowly but surely supplanting the use of grog. The soldiers who captured Tel-el-Kebir drank nothing but tea. It was served out to them three times a day, and they found it most pleasant and invigorating on the march. Its use among athletes and others who perform physical feats is becoming more general. The use of alcohol and tobacco is universally condemned in the various hand-books on training, but the use of tea is always recommended. To the charge that tea-drinking stimulates revolutionary tendencies may be answered that the greatest tea-drinking nation in Asia, the Chinese, is the most conservative, and that the Russians, the greatest tea-drinkers in Europe, are the most stolid of Western peoples. Of great men, Dr. Johnson described himself as "a hardened and shameless tea-drinker." Kant used to breakfast on a cup of tea and a pipe of tobacco, and to work on them for eight hours. De Quincey usually drank tea from eight o'clock at night till four o'clock in the morning. Buckle was a most fastidious tea-drinker. William Howitt regularly took tea and coffee, and found the greatest refreshment in both; and Mr. Gladstone is one of the greatest tea-drinkers of the century.

Variation in Earthquake-Vibrations.—Professor Milne, of Tokio, Japan, making a seismic survey of the ground near his house, placed similarly constructed and tested seismographs at different places, but in similar positions. The result of observing many earthquakes was that all the instruments, the positions of which would be included within a triangle, the sides of which

were eight hundred or nine hundred feet in length, gave different indications as to direction, amplitude, maximum velocity, and intensity; so that, had these instruments been in the hands of different observers, each observer would have given a different account of the same earthquake. Thus, comparing the average maximum velocities at a station, C, on hard ground, with that at a station, E, on soft ground, they were found to be 1 : 5. The maximum accelerations at these two stations were 1 : 2·4. It might therefore be concluded that a building at C would withstand a disturbance which would be sufficient to shatter a similar building placed at E.

NOTES.

A COMMITTEE of the American Society for Psychical Research, of which Josiah Royce, of Cambridge, Massachusetts, is chairman, wishes to collect accounts from trustworthy sources, respecting supposed cases of apparitions of absent or deceased persons, and the communication by them of facts unknown to the person visited by them, or belonging to the future, which are afterward verified. It would also like to receive accounts of other similar personal experiences which may have been striking enough for the persons concerned to remember, or perhaps record. The committee's purpose is to collate and examine the evidence presented, with a view to drawing such conclusions from it as may seem proper and warranted. The committee's circular, which may be obtained on application to the chairman, contains a full statement respecting the kind of information it seeks, with a schedule of questions which may be useful as a guide in making up the accounts.

THE summer courses in chemistry, to be given at Harvard University this year, will open July 5th and close August 14th. Instruction will be given under the direction of Dr. A. M. Comey in general chemistry, qualitative analysis, organic chemistry, and mineralogy. The fee for any of these courses is twenty-five dollars, and material and apparatus usually cost from five to six dollars additional. It is desired that applications for desks in the laboratory be made before June 15th. These courses are taken each year by teachers, both male and female, who are preparing to teach chemistry, by persons who intend to use their knowledge in the arts, and by general students.

WOOD-OIL is now made on a large scale in Sweden from the refuse of timber-cuttings and forest-clearings, and from stumps and roots. Although it can not well be burned in common lamps, on account of the heavy proportions of carbon it contains, it furnishes a satisfactory light in lamps especially made for it, and in its natural state is the cheapest of all illuminating oils. Thirty factories produce about 40,000 litres of the oil daily. Turpentine, creosote, acetic acid, charcoal, coal-tar oils, and other useful substances, are also obtained from the same materials as is the wood-oil.

M. H. FAYOL reports that a number of oaken piles which have seen nine years of service at Mières, Spain, have taken on the appearance of stone-coal. The structure resembles that of a fibrous coal composed of bright particles separated by dull ones; it also feels like stone-coal. M. Renault states, after a microscopic examination, that the wood of fibers and parenchyma have preserved their characters, and the dottings of the vessels are perfectly clear. Chemical analysis gives a composition analogous to that of lignite. The very black color is ascribed to the presence of tannate of iron.

M. CHEVREUL gave joy to the members of the French Academy of Sciences by resuming his seat among them on the 5th of April, after a few weeks' absence on account of illness. He seemed only slightly weakened, but was otherwise in his usual vigor. The President of the Academy gave him a suitable welcome, and he replied, speaking till he was checked by Dr. Vulpian, his titular physician.

DR. CHARLES OSTEN records, in "The Practitioner," the case of a woman patient who was made sick by eating eggs. She appears to be affected with a family idiosyncrasy against eggs, for she said that they never agreed with her when well; and neither her mother nor grandmother could eat them.

ACCORDING to Professor Virchow, the German Colonial Society has had circulars sent to all European colonies situated in the tropics, requesting observations to be made regarding the question of the acclimatization of Europeans in the tropics, in order that the answers may be ready to be communicated to the German Naturalists' Association at its meeting in September next. An exhibition of objects required in fitting out scientific travelers for their journeys will also be held at the same time with the meeting of the Naturalists.

HERR L. RUTENBERG, of Bremen, has presented the Natural History Society of that city with the sum of £2,500 for a Rutenberg fund, in commemoration of the services rendered to science by his son, the traveler, who was murdered in Madagascar.

A committee of the Paris Academy of Sciences has matured a plan for the foundation of an *Institut Pasteur* for the treatment of rabies, to be open to Frenchmen and to foreigners bitten by dogs or other rabid animals. A public subscription is to be instituted in France and abroad for the foundation of the establishment. The management and application of the subscription will be under the direction of a committee, of which Admiral Jurien de la Gravière, President of the Academy, is chief.

Dr. Dubois, of Paris, has been making experiments on the properties of vaseline as food. Two dogs were fed on soup in which the usual fat was entirely replaced with vaseline. With this diet, the animals even slightly increased in weight; their general state was good, with no loss of appetite, vomiting, or diarrhœa. Whence the experimenter infers that the carburets of hydrogen forming vaseline, though they favor neither oxidation nor saponification like fats, are readily tolerated in the alimentary canal of dogs.

The Marquis de Nadaillac gives man's range of endurance of temperature as equivalent to at least 132° C., or 236° Fahr. His estimate is based on the recorded facts of — 65° C., or — 85° Fahr., observed in the Kara Sea, and 67·7° C., or 151·8° Fahr., in the country of the Tuaricks, in Central Africa.

Dr. Andries, having calculated that accidents from lightning have increased by from three to five fold during the last fifty years, finds that the causes which have been assigned for the phenomena do not account for all. He regards the main cause as lying in the enormous increase in manufactories, locomotives, etc., which fill the air with smoke, steam, and particles of dust of all kinds, while the increased populations contribute their share to the impurity of the atmosphere. His own experiments and those of others have shown that all the electrical phenomena of the air increase in intensity with the increase of dust in it.

The London Sanitary Protection Association registers more than 1,000 members, and reports 1,264 inspections during the year. The general character of the houses inspected was found to be as insanitary as ever, only 5 per cent being found in perfect order, and 9·5 per cent in fairly good order; while in 60 per cent foul air was escaping directly into the house, and in 24 per cent sewage was partly retained under-ground by leakage or choking of pipes.

A periodical descriptive of the contents and additions to the collection has been started by the administration of the Ethnological Section of the Royal Museum at Berlin. The first number contains an account of Dr. Nachtigal's ethnological collections, and other papers of similar interest.

OBITUARY NOTES.

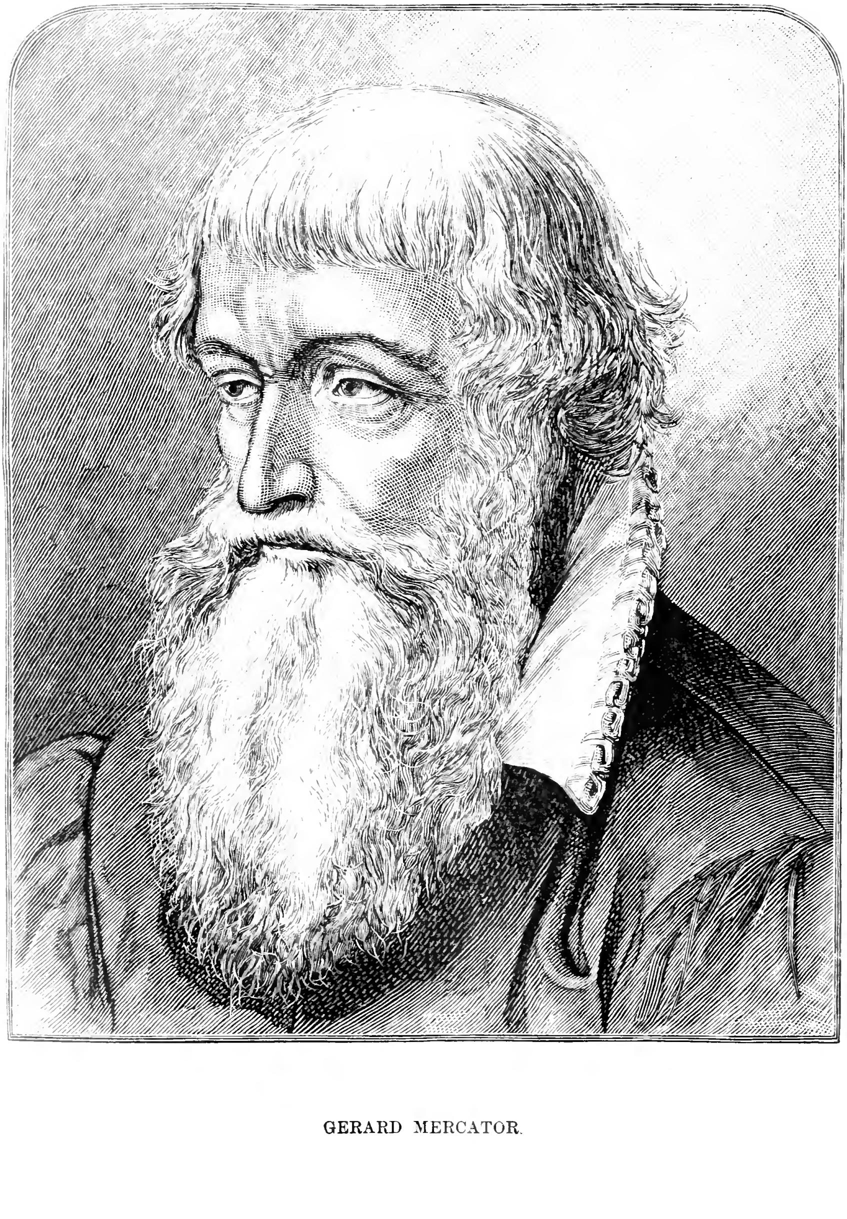
The death is announced of Dr. Moser von Moosbruch, agricultural chemist, of Vienna.

M. Félix Leblanc, Professor of Chemistry in the *École Centrale des Arts et Manufactures*, Paris, is dead. He was for a long time a collaborator with Dumas; and has left his mark in chemical science, particularly in the matter of studies of carbonic oxide. He also gave much attention to electrical investigations, and was a member of the committee on experiments of the International Electrical Exposition of 1881. He was chief inspector of gas in the city of Paris, and Vice-President of the Society for the Encouragement of National Industries.

Johann Jacob von Tschudi, an eminent observer of South American phenomena, died in St. Gall, Switzerland, on the 24th of January last. He was born at Glarus, in 1818, and went from school to Peru, where he lived five years. He gave the public the best account of Peru, and also published books on the fauna of that country, and the ancient Quichua language, a travel-sketch of the Andes, an account of the Brazilian province of Minas-Geraes, the "System of the Batrachians," and finally, a comprehensive book of travels in South America, in five volumes. He was a brother of Friedrich von Tschudi, author of the "Thierleben der Alpenwelt."

Mr. Richard Edmunds, a student of extraordinary agitations of the sea and earthquake-shocks, and of antiquities, died recently at Plymouth, England, in his eighty-fifth year. The results of his seismological investigations are published in the "Edinburgh New Philosophical Journal," the British Association Reports, and the "Transactions of the Royal Society of Cornwall." He also published, in 1862, a book on the "Antiquities, Natural History, Natural Phenomena, and Scenery of the Land's End District."

Dr. T. Spencer Cobbold, Fellow of the Royal and Linnæan Societies, has recently died. He was born in 1828, and received a medical education in practice and at the University of Edinburgh. He was an eminent physician and medical professor. He devoted much attention to the study of morphology and the investigation of the life-history of animal parasites. He prepared the article on "Ruminantia" for the "Cyclopædia of Anatomy and Physiology." In 1868 he was appointed, by the Trustees of the British Museum, Swiney Professor of Geology.



GERARD MERCATOR.

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AN ECONOMIC STUDY OF MEXICO.

By Hon. DAVID A. WELLS.

IV.

TAXATION.—Of all the economic features of Mexico there is no one more novel, interesting, and instructive, and withal more antagonistic in its influence to the development of the country, than the system by which the Government—Federal, State, and municipal—raises the revenue essential to defray its necessary expenditures.

The general characteristics of the Mexican tariff, or system of taxing imports, have been already noticed. But one altogether anomalous and absurd feature of it remains to be pointed out. In all truly civilized countries, when foreign articles or merchandise have once satisfied all customs requirements at a port, or place of entry, and have been permitted to pass the frontier, they are exempted from any further taxation *as imports*, or so long as they retain such a distinctive character.* But, in Mexico, each State of the republic has practically its own custom-house system; and levies taxes on all goods—domestic and foreign—passing its borders; and then, in turn, the several towns of the States again assess all goods entering their respective precincts. The rate of State taxation, being determined by the several State Legislatures, varies, and varies continually with each State. In the Federal District—i. e., the city of Mexico—the rate was recently two per cent of the national tariff; but, in the adjoining State of Hidalgo, it was twelve and a half per cent, and in others it is as high as twenty-five per cent. The rate levied by the towns is said to be about nine per cent of what the State has exacted; but in this there is no

* The right to import is held to carry with it a right to sell on the part of the importer, without further restrictions, i. e., in the original packages. Thus, the United States Supreme Court has decided that a license-tax imposed by a State of the Federal Union, as a prerequisite to the right to sell an imported article, is equivalent to a duty on imports, and in violation of the provision of the Federal Constitution, which prohibits the States from imposing import duties; and the decision has been carefully recognized by the authorities of the several States in dealing with imported liquors under local license or other restrictive laws.

common rule. Thus, under date of April 9, 1886, an official of the Mexican National Railroad writes : "Goods destined for San Luis (i. e., *via* railway) pay a local tax in Laredo, Mexico, but on arrival at San Luis pay a municipal tax. These taxes are eternally changing, and are sometimes prohibitory. Take lumber, for example. Three months ago there was a municipal tax of thirty dollars per one thousand feet. This has now been reduced to one dollar per one thousand feet ; but there is no certainty that the old tax will not be restored." Nor is this all. For the transit of every territorial boundary necessitates inspection, assessment, the preparation of bills of charges, and permits for entry ; and all these transactions and papers involve the payment of fees, or the purchase and affixing of stamps. Thus, by section 377 of the tariff law of December, 1884, it is ordained "that the custom-house shall give to every individual who makes any importation, upon the payment of duties, a certificate of the sum paid, which certificate, on being presented to the administrator of the stamp-office in the place of importation, shall be changed for an equal amount in custom-house stamps. For this operation the interested party shall pay, to the administrator of whom he receives the stamps, two per cent in money (coin) of the total value of the stamps." All imports into Mexico at the present time are liable, therefore, to these multiple assessments ; and the extent to which they act as a prohibition on trade may be best illustrated by a few practical examples.

In 1885, an American gentleman, residing in the city of Mexico as the representative of certain New England business interests, with a view of increasing his personal comfort, induced the landlady of the hotel where he resided (who, although by birth a Mexican, was of Scotch parentage) to order from St. Louis an American cooking-stove, with its customary adjuncts of pipes, kettles, pans, etc. In due time the stove arrived ; and the following is an exact transcript of the bills contingent, which were rendered and paid upon its delivery :

ORIGINAL INVOICE:

1 stove	weight	282 pounds.
1 box pipe	"	69 "
1 box stove-furniture	"	86 "
Total		437 pounds, or 199·3 kilos.

Cost in St. Louis, United States currency	$26 50	
Exchange at 20 per cent	5 30	
Total	$31 80	
Freight from St. Louis to city of Mexico (rail), at $3.15 per 100 pounds	$15 75	
Mexican consular fee at El Paso	4 85	
Stamps at El Paso	45	
Cartage and labor on boxes examined by custom-house at El Paso.	50	
Forwarding commission, El Paso	2 00	
Exchange $16\frac{2}{3}$ per cent on $7.64 freight advanced by Mexican Central Railroad	1 25	
		$56 60

IMPORT DUTIES:

1 box, 128 kilos (stove), iron, without brass or copper ornaments, at 19 cents per kilo	$24 42	
1 box, 31·3 kilos, iron pipe, at 24 cents per kilo	7 51	
1 box iron pots, with brass handles, at 24 cents per kilo	9 48	
	$41 41	
Add 4 per cent as per tariff	1 65	
	$43 06	
Package duty, 50 cents per 100 kilos	1 00	
	$44 06	
Add 5 per cent as per tariff	2 20	
	$46 26	
Add 2 per cent municipal duty	93	
	$47 19	
Add 5 per cent consumption duty	2 36	
	$49 55	
Dispatch of goods at Buena Vista station, city of Mexico	38	
Stamps for permit	50	
		$50 43
		$107 03
Cartage in city of Mexico		75
Total		$107 78

RÉSUMÉ:

Original cost of stove, with exchange	$31 80
Freight, consular fees, and forwarding	24 80
Import duties	50 43
Cartage	75
Total	$107 78

[NOTE.—This stove was shipped from El Paso in a lot of goods for Messrs. —— & Co., the largest importing house in Mexico, thereby saving an expense of two thirds the consular fee—$14.56—which, if paid on the invoice alone, would have added $9.71 to charges, and raised the total to $117.49.]

In 1878 Hon. John W. Foster, then United States minister to Mexico, in a communication to the Manufacturers' Association of the Northwest (Chicago), thus analyzed the items of the cost, in the city of Mexico, of a tierce, weighing gross 328 pounds, containing 300 pounds (net) of sugar-cured hams:

New York cost, 300 pounds at 11 cents	$33 00
New York expenses, such as cartage, consular invoice ($4 gold), manifest, etc., average 5 per cent on large shipments	1 65
Freight from New York to Vera Cruz at 1 cent per pound, payable in New York	3 25
Exchange on New York, $37.90 at 18 per cent	6 82
Import duties in Vera Cruz, 138 kilos at 24 cents per kilo	33 12
Municipal duties in Vera Cruz, $1.03 for every 400 pounds	84
Lighterage and handling from steamer to warehouse ($1 to $1.50 per every 200 pounds)	1 63
Maritime brokerage, 2 per cent on freight ($3.25)	07

Opening and closing barrel	50
Additional charges in Vera Cruz for stamps and cartage to railroad-station, etc.	1 50
Commission in Vera Cruz, 2 per cent on $70.66	1 41
Exchange on Vera Cruz, 1 per cent on $39.06	39
Railroad freight from Vera Cruz to Mexico, 140 kilos, at $54.32 a ton	7 60
Local duties in city of Mexico, 2 per cent on Federal duty, $33.12	66
Local expenses in city of Mexico, cartage from depot, expenses in custom-house, etc	75
Total	$93 19

The net cost of one pound of imported American ham in the city of Mexico in 1878 was therefore 31 cents, or $1 in hams in New York was equal to $2.82 in Mexico!

A similar analysis showed an invoice of ten kegs of cut nails, costing two and a half cents per pound in New York, or $22.50, to have cost $14\frac{16}{100}$ cents per pound, or $141.64, when imported, in the city of Mexico; or $1 value in nails in New York was equal to $6.29 in Mexico. In the case of salt, costing $2 per barrel in New York, the cost of importation was $20.40; or $1 of salt in New York was equal to $10.20 in Mexico! And in the case of (Milwaukee) beer, a barrel costing, on board steamer in New Orleans, $13, cost $35.61 in the city of Mexico. It is clear, therefore, as Mr. Foster points out in connection with the above exhibits, "that articles of the most common use in the United States must be luxuries in Mexico, on account of their high price"; and that while "this would be the case, with such charges, in almost any country, however rich it might be, it is especially so in Mexico, where there is so much poverty."

Again, the Mexican tariff provides that the effects of immigrants shall be admitted free. "But this," writes an officer of the Mexican National Railroad Company, "is practically a dead letter, from the fact that interior duties are levied on everything the immigrant has, before he gets settled; and these are so great that no one goes. I've never known but one case go through Laredo. . . . A carpenter, or other mechanic, who desires to get employment in Mexico, has such heavy duties levied on his tools on passing the national or State frontiers, that few are willing or able to pay them. Hence few American mechanics find their way into the country, unless in accordance with special contract."

This practice of locally taxing interstate commerce is in direct contravention of an article in the Mexican Constitution of 1857, and it is said also of express decisions of the national Supreme Court. Several of the leading States of Mexico have at different times tried the experiment of prohibiting it by legislative enactments; but the States and municipalities of the country are always hard pressed to raise money for their current expenditures, and find the taxing of merchandise in transit so easy a method of partially solving their dif-

ficulties, that the Federal authorities have not yet been able, or, speaking more correctly, willing to prevent it.* It is important, however, to note here that, in the draft of the proposed reciprocity treaty between the United States and Mexico, it is provided that imports from the United States into Mexico, admitted free under the treaty, shall not be liable to any Mexican State duties.

The Mexican tariff system also provides for the taxation of exports, notably on the following products: gold bullion, one fourth of one per cent; silver bullion, one half of one per cent; coined gold and silver, having already paid at the mint, exempt; orchil, $10 per ton; wood for cabinet-work and construction, $2.50 per 31·3 American cubic feet. Small export duties are also imposed on coffee and heniquen. A revision of the Mexican tariff, with a view of modifying certain of its exorbitant duties, more especially those levied on the importation of wines and liquors and certain articles of food, has been recently recommended (1885) to the Government by a committee of delegates of prominent men of business from different parts of the republic.

The existence in a state of the New World of a system of taxation so antagonistic to all modern ideas, and so destructive of all commercial freedom, is certainly very curious, and prompts to the following reflections: First, how great was the wisdom and foresight of the framers of the Constitution of the United States in providing, at the very commencement of the Federal Union, that no power to tax in this manner, and for their own use or benefit, should ever be permitted to the States that might compose it (Article I, section 10). Second, how did such a system come to be ingrafted on Mexico, for it is not a modern contrivance? All are agreed that it is an old-time practice and a legacy of Spanish domination. But, further than this, may it not be another one of these numerous relics of European mediævalism which, having utterly disappeared in the countries of their origin, seem to have become embalmed, as it were, in what were the old Spanish provinces of

* In October, 1883, in response to a call of the President of the Republic, the Governors of the several States of Mexico appointed each two delegates, who assembled in convention at the capital, and after some deliberation published a report which exhibited the incompatibilities, disadvantages, and abuses of the system in the most convincing manner; but acknowledging, at the same time, that as all the State governments were more or less dependent upon it for their revenues, they could not recommend its present abolition. The report also concluded with a recommendation "that Congress should at once legalize a practice which a constitutional prohibition had failed to prevent, and which, under existing circumstances, it would be impolitic to suppress entirely." And, in deference to the suggestions of this conference, the Mexican Congress subsequently passed a law, with a view of modifying and limiting the authority of the State and municipal custom-house officers, so as to lessen in a degree the interruptions and vexations incident to the system. But as the Federal Government and some of the States have since then authorized public improvements to an extent that the state of their finances did not justify, and have in consequence increased taxes in all possible forms throughout the republic, the prospect for the complete suppression, or even of any essential modification, of this oppressive system of taxation is not flattering.

America—a system filtered down through Spanish traditions from the times when the imposition of taxes and the regulation of local trade was regarded by cities and communities in the light of an affirmation of their right to self-government, and as a barrier against feudal interference and tyranny; and when the idea of protecting industry through like devices was also not limited as now to international commerce, but was made applicable to the commercial intercourse of cities and communities of the same country, and even to separate trades or "guilds" of the same city? Whether such speculations have any warrant in fact or not, it is at least certain that we have in the Mexico of to-day a perfect example of what was common in Europe in the middle ages; namely, of protection to separate interests (through taxation) carried out to its fullest and logical extent, and also of its commercial and industrial consequences.

So much for the tariff system of Mexico. The "excise" or "internal revenue" system of the country is no less extraordinary. It is essentially a tax on sales, collected in great part through the agency of stamps—a repetition of the old "*alcavala*" tax of Spain,* which Adam Smith, in his "Wealth of Nations," describes as one of the worst forms of taxation that could be inflicted upon a country, and as largely responsible for the decay of Spanish manufactures and agriculture. Thus the Mexican law, re-enacted January, 1885, imposes a tax of "one half of one per cent upon the value in excess of $20 of transactions of buying or selling of every kind of merchandise, whether at wholesale or retail, in whatever place throughout the whole republic." Also, one half of one per cent "on all sales and resales of country or city property; upon all exchanges of movable or immovable property; on mortgages, transfers, or gifts, collateral or bequeathed inheritances; on bonds, rents of farms, when the rent exceeds $2,000 annually; and on all contracts with the Federal, State, or municipal governments." Every inhabitant of the republic who sells goods to the value of over $20 must give to the buyer "an invoice, note, or other document accrediting the purchase," and affix to the same, and cancel, a stamp corresponding to the value of the sale. Sales at retail are exempt from this tax; and retail sales are defined to be "sales made with a single buyer, whose value does not exceed $20. The reunion, in a single invoice, of various parcels, every one of which does not amount to $20, but which in the aggregate exceed that quantity," remains subject to the tax. Retail sales in the public markets, or by ambulatory sellers, or licensed establishments, whose capital does not exceed $300, are also exempt. Tickets of all descriptions—railroad, theatre, etc.—must have a stamp, as must each page of the reports of meetings; each leaf of a merchant's ledger, day or cash book, and every cigar sold singly, which must be delivered to the buyer in a stamped wrapper. Sales

* The very name is yet essentially kept up in Mexico, where the tax is sometimes designated as the "*alcabala*."

of spirits at wholesale pay three per cent; gross receipts of city railroads, four per cent; public amusements, two per cent upon the amount paid for entrance; playing-cards, fifty per cent—paid in stamps—on the retail price; and manufactured tobacco a variety of taxes, proportioned to quality and value. Mercantile drafts are taxed at $10 per $1,000, which means a dollar on every hundred.

Farms, *haciendas*, and town estates are required to be taxed at the rate of $3 per each $1,000 of the valuation, but such is the influence of the land-owners that the valuation is almost nominal. Land and buildings not actually producing income are exempt from taxation, notwithstanding they may be continually enhancing in value.*

In the towns, this system of infinitesimal taxation is indefinitely repeated; the towns acting as collectors of revenue for the Federal and State governments, as well as for their own municipal requirements. All industries pay a monthly fee: as tanneries, 50 cents; soap-factories, $1. So also all shops for the sale of goods pay according to their class, from a few dollars down to a few cents per month. Each beef animal, on leaving a town, pays 50 cents; each fat pig, 25 cents; each sheep, 12 cents; each load of corn, fruit, or vegetables, 6 cents, and so on; and, on entering another town, all these exactions are repeated. A miller, in Mexico, it is said, is obliged to pay thirty-two separate taxes on his wheat, before he can get it from the field and offer it, in the form of flour, on the market, for consumption. As a matter of necessity, furthermore, every center of population—small and big, city, town, or hamlet—swarms with petty officials, who are paid to see that not an item of agricultural produce, of manufactured goods, or an operation of trade or commerce or even a social event, like a *fandango*, a christening, a marriage, or a funeral, escapes the payment of tribute.

In fact, trade is so hampered by this system of taxation, that one can readily understand and accept the assertion that has been made, that people with capital in Mexico really dread to enter into business, and prefer to hoard their wealth, or restrict their investments to land (which, as before pointed out, is practically exempt from taxation), rather than subject themselves to the never-ending inquisitions and annoyances which are attendant upon almost every active employment of persons and capital, even were all other conditions favorable. Mexico, from the influence of this system of taxation alone, must, therefore, remain poor and undeveloped; and no evidence or argument to the contrary can in any degree weaken this assertion. Doubtless there are many intelligent people in Mexico who recognize the gravity of the situation, and are most anxious that something should be done in the way of reform. But what can be done? If autocratic powers were

* This practice of exempting unoccupied realty from taxation also prevails in Portugal. The theory there in justification of the practice is, that the use of a thing defines its measure of value, and that to tax unused property is a process of confiscation.

to be given to a trained financier, thoroughly versed in all the principles of taxation and of economic sciences, and conversant with the results of actual experiences, the problem of making things speedily and radically better in this department of the Mexican state is so difficult that he might well shrink from grappling with it.

In the first place, the great mass of the Mexican people have little or no visible, tangible property which is capable of direct assessment.

Again, in any permanent system of taxation, taxes in every country or community, in common with all the elements of the cost of production and subsistence—wages, profits, interest, depreciation, and materials—must be substantially drawn from each year's product. Now, the annual product of Mexico is comparatively very small. Thus, for example, Mr. Sutton, United States consul-general at Matamoros, as before noticed, has shown that the annual product of the single State of South Carolina is absolutely two and a half times—or, proportionally to area, twenty-five times—as valuable as the annual product of the entire northern half of Mexico; and the Argentine Republic of South America, with only one third of the population of Mexico, has a revenue twenty per cent greater, and double the amount of foreign commerce. Product being small, consumption must of necessity be also small. Ex-Consul Strother (report to State Department, United States, 1885) says: "The average cost of living (food and drink) to a laboring-man in the city of Mexico is about twenty-five cents per day; in the country from twelve and a half to eighteen cents. The average annual cost of a man's dress is probably not over five dollars; that of a woman double that sum, with an undetermined margin for gewgaws and cheap jewelry." Mr. Lambert, United States consul at San Blas, reports under date of May, 1884: "The average laborer and mechanic of this country may be fortunate enough, if luck be not too uncharitable toward him, to get a suit of tanned goat-skin, costing about six dollars, which will last him as many years."

The food of the masses consists mainly of agricultural products—corn (*tortillas*), beans (*frijoles*), and fruits, which are for the most part the direct results of the labor of the consumer, and not obtained through any mechanism of purchase or exchange.

Persons conversant with the foreign commerce of Mexico are also of the opinion that not more than five per cent of its population buy at the present time any imported article whatever; or that, for all purposes of trade in American or European manufactures, the population is much in excess of half a million. Revenue in Mexico from any tariff on imports must, therefore, be also limited; and this limitation is rendered much greater than it need be by absurdly high duties; which (as notably is the case of cheap cotton fabrics) enrich the smuggler and a few mill-proprietors, to the great detriment of the national exchequer.

It is clear, therefore, that the basis available to the Government

for obtaining revenue through the taxation of articles of domestic consumption, either in the processes of production, or through the machinery of distribution, is of necessity very narrow; and that if the state is to get anything, either directly or indirectly, from this source, there would really seem to be hardly any method open to it, other than that of an infinitesimal, inquisitorial system of assessment and obstruction, akin to what is already in existence.*

NOTE.—This curious tax experience of Mexico, although especially striking and interesting, is not exceptional, but finds a parallel, in a greater or less degree, in all countries of low civilization, small accumulation of wealth, and sluggish society movement. Thus, in the British island and colony of Jamaica, populated mainly by emancipated blacks and their descendants (554,132 out of a total of 580,804 in 1881), who own little or no land, and through favorable climatic conditions require the minimum of clothing and shelter, and little of food other than what is produced spontaneously, or by very little labor, the problem of how to raise revenue by any form of taxation, for defraying the necessary expenses of government, has been not a little embarrassing. For the year 1884, the revenue raised from taxation on this island represented an average assessment of about $3.40 per head of the entire population; but of this amount an average of about fifty cents only per head could be obtained from any excise or internal taxation; and this mainly through the indirect agency of licenses and stamps, and not by any direct assessment. The balance of receipts was derived from import and export duties, and from special duties on rum, which last furnished nearly one fourth of the entire revenue. During the same year the average taxation of the people of the United States—Federal, State, and municipal—was in excess of fourteen dollars per capita. A condition of things in British India, analogous to that existing in Jamaica, has for many years necessitated the imposition of very high taxes upon salt, as almost the only method by which the mass of the native population could be compelled to contribute anything whatever toward the support of their government; the consumption of salt being necessary to all, and its production and distribution being capable of control, and so of comparatively easy assessment. In short, if a man can avoid paying rent, make no accumulations, and will live exclusively on what he can himself gather from the bounty of Nature, he can not be taxed, except by a capitation or poll-tax; and it would be difficult to see how in such a case even such a tax could be collected. But, the moment he enters into society and recognizes the advantages of the division of labor and exchange, he begins to pay taxes, and the higher the civilization he enjoys the greater will be the taxes.

But the greatest obstacle in the way of tax reform in Mexico is to be found in the fact that a comparatively few people—not ten thousand out of a possible ten million—own all the land, and constitute, in the main, the governing class of the country; and the influence of this class has thus far been sufficiently potent to *practically* exempt land from taxation. So long as this condition of things prevails, it is difficult to see how there is ever going to be a middle class (as there is none now worthy of mention), occupying a position intermediate between the rich and a vast ignorant lower class, that take no interest in public affairs, and are only kept from turbulence through military restraint. Such a class, in every truly civilized and progressive coun-

* The experience of Mexico in respect to taxation ought to be especially instructive to all that large class of statesmen and law-makers in the United States who believe that the only equitable system of taxation is to provide for an obligatory return and assessment of all property, and that to exempt anything is both unjust and impolitic.

try, is numerically the greatest, and comprises the great producers; and because the great producers, the great consumers and tax-payers—for all taxes ultimately fall upon consumption—and so are the ones most interested in the promotion and maintenance of good government. A tax policy, however, which would compel the land-owners to cut up and sell their immense holdings, especially if they are unwilling to develop them, would be the first step toward the creation of such a middle class. But it is not unlikely that Mexico would have to go through one more revolution, and that the worst one she has yet experienced, before any such result could be accomplished. At present, furthermore, there is no evidence that the mass of the Mexican people, who would be most benefited by any wise scheme for the partition of the great estates and for tax reform, feel any interest whatever in the matter, or would vigorously support any leader of the upper class that might desire to take the initiative in promoting such changes. And herein is the greatest discouragement to every one who wishes well for the country.

The Federal budget, in respect to expenditures for the fiscal year 1886–'87, as reported by President Diaz to the Mexican Chamber of Deputies, was as follows:

Congress	$1,052,144
Executive Department	49,251
Judiciary	434,892
Ministry of Foreign Affairs	419,828
Ministry of Interior	3,539,364
Ministry of Justice	1,333,696
Ministry of Public Works	4,711,771
Ministry of Finance	12,004,270
Ministry of War and Navy	12,464,500
Total	$36,009,716

The estimates of receipts were uncertain. It was hoped, if business recovered, that they would reach $33,000,000; and the Government promised to try and restrict the national expenditures to this amount.

As for the sources of national revenue, the customs are understood to yield about one half; taxes on sales and stamps, some $5,000,000; post-offices and telegraph lines, $650,000; lotteries, $800,000; while the receipts from taxes levied by the States (mainly on sales also) amount to from $8,000,000 to $10,000,000, or about one half the receipts from customs.

In respect to the foreign commerce of Mexico, a report on the "Commercial Relations of the United States," issued by the United States Department of State in 1883, says: "Owing to the system, or, rather, to the lack of system, in regard to the collection and publication of customs returns by the national Government, it is impossible for our consuls in Mexico to supply any trustworthy statistics concern-

ing the foreign commerce of the republic." An approximative estimate of the results for 1880 was as follows :

Exports	$32,663,554
Imports	24,003,372
Total	$56,666,926

The precious metals—coin, bullion, and ores—always constitute the great bulk of what Mexico exports ; and the proportion of agricultural products or other merchandise exported is surprisingly small. Thus, out of the total value of exports for 1884, estimated by Consul-General Sutton at $39,716,000, nearly three fourths, or $28,452,000, were credited to the precious metals, and only $11,264,000 to all other commodities ; and, of these last, the largest proportion always consists of articles produced near the seaboard, or near the line of the City of Mexico and Vera Cruz Railroad. During recent years, and since the construction of the so-called American railroads, the increase in the exports from Mexico, of products other than the precious metals, has, however, been very notable, and is apparently progressive. But the fact that the exports of Mexico *always* largely exceed her imports, that the great bulk of the exports are *always* the precious metals, and that the excess of imports does not represent payment for interest to any extent on any national foreign indebtedness, naturally creates a suspicion that the whole (export) transaction is something abnormal ; which may find an explanation in the existence of a class of wealthy absentee landlords, or proprietors, who, living permanently in Paris or Spain, draw rents, tolls, and profits from their Mexican properties, and invest or expend the same in other, or foreign countries. The bulk of the coinage of Mexico—both of silver and of gold—is exported almost as soon as it leaves the mints. Thus, although the average annual coinage of the Mexican mints from 1876 to 1880 was $22,524,694, and since then has been larger ($25,610,000 in 1881–'82), the amount of coin in actual circulation in the country is believed to have never been in excess of $15,000,000 or $20,000,000. Much of the Mexican coined silver has, as is well known, been heretofore in large demand to meet the world's requirements for trade with China ; but what has come back to Mexico for it in exchange is somewhat of a commercial puzzle.

In a report to the State Department (May, 1884), ex-Consul-General Strother thus briefly sums up the obstacles (heretofore noticed more in detail in this series of papers) which stand in the way of the future development of the commerce of Mexico. He says : "Topographically considered, Mexico labors under many serious disadvantages to commerce, whether external or internal. Her coasts on both oceans are broad belts of intolerable heat, disease, and aridity, and, except a few small seaport towns, are nearly uninhabited. On the whole extent of her coast-line there are but two natural harbors available

for first-class modern merchant-vessels—those of Anton Lizado on the Gulf, and Acapulco on the Pacific. All the other so-called seaports now used by commerce are open roadsteads, dangerous in rough weather, and only approachable in lighters, or are located on rivers, the entrances to which are closed to ocean traders by shallows or sand-bars. The natural obstructions and difficulties in the way of inland traffic are scarcely less observable. Mexico is entirely wanting in navigable rivers and lakes. Her fertile districts, capital cities, and centers of population are separated from each other by long distances, arid districts, immense chains of mountains, and vast *barrancas* washed out by her rapidly descending water-courses. These difficulties were partially overcome by the Spaniards, who constructed a noble system of highways and bridges extending between the principal cities of the viceroyalty, but from the nature of the soil they were immensely expensive to construct and difficult to maintain. During the long and ruinous wars for independence, and the civil wars which followed, these highways went rapidly to destruction; and, notwithstanding recent repairs and reconstructions, the general condition of Mexican highways is not encouraging to either commerce or travel. But all these natural and accidental disadvantages combined may be regarded as nothing in comparison with the crushing and suffocating influences brought to bear on Mexican commerce, foreign and domestic, by the exclusive policy imposed by the mother-country during the three centuries of Mexico's colonial vassalage; and, secondly, by the system of internal and interstate duties and custom-houses, inherited from Old Spain, which still practically vexes the internal commerce of the republic."

Relation of the Sanitary Condition of Mexico to its Commercial Development.—The sanitary condition of every country constitutes an important element in determining its commercial development, and Mexico especially illustrates the truth of this proposition. The coast-lands of the republic are hot and unhealthy. The more elevated portions, where nine tenths of the people live, are claimed to be unsurpassed in salubrity. Strangers from northern latitudes, and accustomed to the ordinary levels of human residence, are liable, on coming to the Mexican plateau, to a process of acclimation, which, although often very trying, is rarely attended with any very serious consequences. Horse-dealers from Texas state that they lose from twelve to twenty per cent of the horses brought to the city of Mexico for sale, solely from the climatic influences contingent on its great altitude; and the common house-cat, it is said, does not thrive, and is scarce on the highlands of Mexico for like reasons. The sanitary conditions of the two chief commercial centers of the republic, namely, the city of Mexico and of Vera Cruz, are, however, so extraordinary and so obstructive to national progress that any review of the country would be imperfect that neglected to notice them. The evil in the

case of the former is local and not climatic, and is due to the circumstance that the site of the city is "a bowl in the mountains," so that drainage from it is now, and always has been, very difficult. And, as years have passed, and the population living within the bowl has multiplied, the evil has continually increased, until Lake Tezcoco, which borders the city, and on which Cortes built and floated war-galleys, has been nearly filled up with drainage deposits which have been carried into it through an elaborate system of city sewers. If these sewers ever had fall enough to drain them, they have, as the result of the filling up of this lake, little or none now, and the result is that they have become in effect an immense system of cess-pools; while the soil, on which from 250,000 to 300,000 people live, has become permeated throughout with stagnant water and filth inexpressible. And were it not for the extreme dryness and rarefaction of the air, which, as before pointed out, prevent the putrefaction of animal substances, and seem to hinder the propagation of the germs of disease, the city must long ago have been visited with plague, and perhaps have been rendered absolutely uninhabitable. And, even under existing circumstances, the average duration of life in the city of Mexico is estimated to be but 26·4 years. Typhoid fever prevails all the year round, and is especially virulent at the end of the dry season, when the heat is the greatest. And, surprising as it may seem, with a climate of perpetual spring and an elevation of 7,500 above the sea-level, lung and malarial diseases hold a prominent place among the causes of death. According to the reports of the Board of Health of the Mexican capital for April and May of the present year (1886), thirty-three per cent of the weekly mortality at that season was to be referred to typhoid and other forms of gastric fever, and twenty per cent to consumption and pneumonia. In the year 1877, when a typhus epidemic prevailed, the city's mortality was reported to have been as high as 53·2 per thousand as compared with an average death-rate of 24·6 in Paris for the same year. "A distinguished member of the medical faculty of Mexico has lately published a report, in which he demonstrates, by comparative statistical tables, that the annual mortality of the city is increasing to such an extent as already to counterbalance the natural movement of the population, and, if not checked in time, as threatening the race." *—"United States Consular Reports," No. 3, 1881, p. 18.

This condition of affairs is not due, as some might infer, to any improvidence or want of enterprise on the part of the Mexicans, for

* Under the title of the "Great Necropolis," one of the prominent Mexican newspapers, the "Correo del Lúnes," recently said: "Undisguised terror is caused by these processions of the dead which daily defile through the streets of Mexico. To be alive here is getting to be a startling phenomenon. It may be a very short time, unless energetic remedial measures are adopted, before the capital will have to be moved to another location."

the evil has long been recognized, and at present especially interests the Government. But the difficulties in the way of applying an efficacious remedy are very great, and engineers are not fully agreed as to the best method for attaining the desired result. "For such is the nature of the plain upon which Mexico is built, such the conformation of the land and the contour of the mountains about it, that a vast system of tunneling and canalization would be necessary to create a fall sufficient to drain the valley; and, before the city can be drained, the valley must be." It is said that one celebrated American engineer, whose advice was recently asked by the Government, reported that, if a thorough drainage could be effected, the city, through a consequent shrinkage of soil, would probably tumble down. And, finally, the existing condition of the national and municipal finances is such, that it is not easy for the authorities to determine how the money necessary to meet the contingent great expenditures—estimated at about $9,000,000, or a sum equivalent to more than one third of the entire annual revenue of the General Government—is to be provided.

It ought not to be inferred that there is special danger to travelers, or tourists, visiting the Mexican capital, and residing there during the winter months or early spring; for experience shows that, with ordinary precautions in respect to location, diet, exercise, and exposure, health can be maintained there as easily as in most of the cities of Italy at the same seasons.

At Vera Cruz, the local name of which is "El Vomito" (a term doubtless originating from the continued prevalence in the town of yellow fever), the sanitary conditions are much worse than in the city of Mexico; and the causes of the evil, being mainly climatic, are probably not removable. The statistics of mortality at this place, gathered and published by the United States Department of State, are simply appalling. Thus, the population of Vera Cruz in 1869 was returned at 13,492. The number of deaths occurring during the ten years ending September, 1880, was 12,219. The average duration of life in Vera Cruz for this period was, therefore, about eleven years! Other calculations indicate the average annual death-rate of this place to be about ninety per thousand, as compared with the annual average for all the leading cities of the United States for the year 1880, of 22·28 per thousand.

The writer feels that he would be guilty of a grave omission, in this connection, if he failed to quote and also to indorse the words with which the United States consul, who gathered and communicated these facts, thus concludes his official report, October, 1880: "With these awful facts before me, I leave it to the common judgment and high ideas that our law-makers have of justice to say whether or not the salary of the consul who, for eleven years, has lived in such an atmosphere, ought or ought not to be placed at least back to where it was when he was sent here."

[NOTE.—No more striking illustration of the popular "craze" for public office can be found than in the circumstance that, although an appointment to the United States consulate at Vera Cruz (salary in 1884, $3,000) is equivalent to investing in a lottery of death, in which the chances to an unacclimated person for drawing a capital prize are probably as great as one to seven or eight, no lack of applicants for the place is ever experienced. Thus, the consul whose appeal for an increase of salary is above noticed, was appointed from Illinois, and resigned in 1881. His successor, appointed from Nebraska, died of yellow fever a fortnight after arrival at his post; and since then there have been two appointments, one from Nebraska and one from New Jersey.]

This, then, is what the writer has to report respecting the economic condition and prospects of Mexico. His conclusions have not come to him, as perhaps may be inferred or charged, mainly from a somewhat extended but brief tour of observation; for no one can be more conscious than he of how little one can know of a country who, ignorant of the language, the customs, the political and social condition and pursuits of its people, sees it simply and hurriedly as a traveler. But the journey in question was, nevertheless, sufficiently extensive and instructive to thoroughly satisfy at least as to two points: First, that here was a country, bordering on the United States for a distance of more than two thousand miles, which was almost as foreign to the latter, in respect to race, climate, government, manners, and laws, as though it belonged to another planet; and, secondly, that the people of the United States generally knew about as much of the domestic concerns of this one of their nearest neighbors as they did about those of the empire of China. The temptation to enter upon a field of economic investigation so fresh and so little worked was too attractive to be resisted; and, accordingly, with the sole purpose of desiring to know the truth about Mexico, and to form an opinion as to what should be the future political and commercial relations between that country and the United States, the writer has made a careful study of a large amount of information that he has found accessible, both from public and private sources. And it is on the basis of this study, and with the kindliest feeling for and the deepest interest in Mexico, that he has written. In so doing, however, he claims nothing of infallibility. He frankly confesses that in respect to some things he may be mistaken; and that others might draw entirely different conclusions from the same data.* But for the entire accuracy

* One curious illustration of this point is to be found in the following extract from a letter recently addressed to the Mexican "Financier" by a Mexican gentleman, in contravention of the writer's opinions respecting the present industrial condition and prospective development of Mexico. He says: "If you pass through the Academy of San Carlos, you will see pictures executed by native Mexican artists in the highest style of art, comparing most favorably with any production of the academies of design of Paris, Rome, Munich, or elsewhere. Go with me, if you please, to a narrow lane in the small but picturesque city of Cuernavaca, and there in a small room, working with implements of his own make, you will observe a native, whom you would perhaps class among the peons, carving a crucifix in wood, so highly artistic, with the expression of suffering on our Saviour's face so realistic, that any foreign sculptor of the highest renown would be proud to call it a

of most statements and deductions, he believes he finds ample warrant in the published diplomatic and consular correspondence of the United States during the last decade, and in an extensive personal correspondence with railroad and commercial men, who, from continuous residence, have become well acquainted with Mexico.* Making every allowance, however, for differences of opinion respecting minor details, the main facts and deductions that have been presented (which can not well be questioned or disputed) are all that are essential for an intelligent discussion of the possible or desirable relations of the United States to Mexico in the future; and it is to a consideration of this matter that the attention of the reader is next invited.

creation of his own. Again, visit with me the village of Amatlan de los Reyes, near Córdoba, and observe the exquisitely embroidered *huipilla* of some native woman, surpassing in many respects the designs of the art-needlework societies of New York or Boston; not to mention the fine filigree-work, figures in clay and wax as executed by the natives in or near the city of Mexico, the art pottery of Guadalajara, the gourds, calabashes, and wooden trays highly embellished by native artists, whose sense or acceptation of art is not acquired by tedious study at some academy of design, but is inborn and spontaneously expressed in such creations. Only yesterday in my walks about town I entered the National Monte de Piedad, where I heard the sweetest and most melodious strains from a grand piano of American make, and beheld, to my astonishment, that the artist was a native, a *cargador*, or public porter, clad in cheap *sombrero*, blouse, white cotton trousers, and sandals, with his brass plate and rope across his shoulders, ready to carry this very instrument on his back to the residence of some better-favored brother from a foreign land. If this is not innate genius, I know not what else to call it." To this it may be replied that the facts as above stated are probably not in the least exaggerated. There is undoubtedly in the Mexican people, inherited from their Spanish ancestry, much of æsthetic taste and an "innate genius" for music, painting, sculpture, embroidery, dress, decoration, and the fine arts generally. But this very fact, in view of the hard, rough work that Mexico has got to do to overcome the natural obstacles in the way of her material development, is not a matter of encouragement. For it is not genius to carve crucifixes, embroider *huipillas*, or compose and execute music that her people need; but rather the ability to make and maintain good roads, invent and use machinery, and reform a system of laws that would neutralize all her natural advantages, even though they were many times greater than the most patriotic citizen of the country could claim for it.

* From one of these latter the following warning against publishing anything in the way of observations or conclusions was received by the writer:

"City of Mexico, *April* 13, 1886.

"The papers are filled with the letters of travelers about Mexico. If you do not conform to what many people here want you to say, you are put down as having taken a hasty or dyspeptic observation of the country, and had no opportunity to know anything. If you pass one week in an hotel, and should write conformably to what various interests would have you, you are at once quoted as a 'most intelligent and experienced traveler.' A thorough investigation scrapes off all the varnish, and will often expose the motives of not a few people in Mexico, who would have American capital plant itself there under conditions which afford no protection by their Government or ours."

EARTHQUAKES AND OTHER SEISMIC MOVEMENTS.*

WE are accustomed to think of the land of the earth as something solid and fixed; and, as a testimonial of this impression, the Latin phrase *terra firma*, firm land or solid ground, has been naturalized in the languages of nearly all civilized peoples. On the other hand, we speak of water as unstable. But the geological history of the earth and the more careful observations of modern times have taught us that these ideas do not correctly represent the qualities of the land-masses and water-masses of the globe as compared with one another. The ancient shore-marks on the continents and the phenomena of elevation and subsidence that have been observed in historic times, confirming their evidence, show that the land and the ocean are continually changing their level as to one another; and it has further been made evident, by experiment, as well as by *a priori* reasoning, that it is not the ocean that changes, but the land which undergoes alternate movements of elevation and depression. An earthquake-shock is a phenomenon well adapted to destroy the faith of any person who feels one in the fixedness of the earth; and such, by the evidence, is the effect for the time on all who experience these shocks. Even the light pulsations which sometimes pass over parts of the United States occasion panic and excite a momentary impression that everything is falling over or sinking away; while the more violent shocks that are felt in earthquake-infested countries produce indescribable terror; and such catastrophes as those historical earthquakes of Lisbon and Carácas, and the more recent ones of Ischia and the Strait of Sunda amount to a demonstration that the reason for such terrors is real, and that the continents also can not escape the general law of change and perishability.

Earth-movements—the name by which these phenomena may be most conveniently described—are various, and comprise, so far as they are now considered, earthquakes, or sudden violent movements of the ground; earth-tremors, or minute movements which usually escape attention by the smallness of their amplitude; earth pulsations, or movements which are overlooked on account of the length of their period; and earth oscillations or movements of long period and large amplitude—like the shifting of levels of land-masses—which attract attention from their geological importance. Some of these movements have only recently begun to attract attention. They are all intimately associated in their occurrence and their origin.

The study of earthquakes is of interest to the geologist in many

* Earthquakes and other Earth Movements. By John Milne, Professor of Mining and Geology in the Imperial College of Tokio, Japan. International Scientific Series. No. LV. New York: D. Appleton & Co., pp. 348.

ways. As they seem to be connected with volcanic action, the study of them may help to throw light on that, and *vice versa*. As an earthquake-wave travels along from strata to strata, the study of its reflections and changes in transit may lead to the discovery of peculiarities in rocky structure, of which we should otherwise have no accurate knowledge. It may teach us something about the transmission of disturbances in elastic media, about the earth's magnetism, the electric currents of the earth, and other kindred problems. It is of interest to the meteorologist to know the connections which probably exist between earthquakes and the fluctuations of the barometer, the changes of the thermometer, and the quantity of rainfall. In a practical point, we may ask ourselves what are the effects of earthquakes upon buildings, and how, in earthquake-shaken countries, the buildings are to be made to withstand them.

A typical earthquake consists of a series of small tremors succeeded by a shock, or of a series of shocks separated by more or less irregular—both in period and in amplitude—vibrations of the ground. Man can take but little account of these movements, for they come upon him by surprise, and, by the time he is ready to begin to observe, they are over. Hence we must have recourse to instruments. It is easy enough to construct an instrument that shall move at the time of an earthquake, and leave a record of its motion—a *seismoscope;* but an instrument that shall record the period, extent, and direction of each of the vibrations constituting the earthquake—a *seismometer* or *seismograph*—is a more complicated affair.

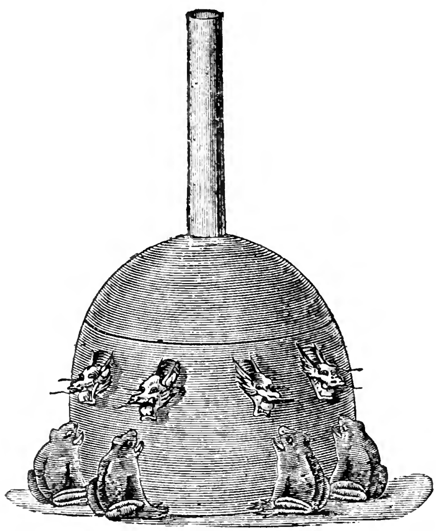


Fig. 1.

The earliest seismoscope of which we find any historical record is that of the Chinese Chôko, which was invented in A. D. 136. According to the historical account given of it, it consisted of a spherically formed copper vessel (Fig. 1), eight feet in diameter. "Its outer part," the account says, "is ornamented by the figures of different kinds of birds and animals, and old, peculiar-looking letters. In the inner part of this instrument is a column so suspended that it can move in eight directions. Also, in the inside of the bottle, there is an arrangement by which some record of an earthquake is made according to the movement of the pillar. On the outside of the bottle there are eight

dragon-heads, each of which holds a ball in its mouth. Underneath these heads there are eight frogs so placed that they appear to watch the dragon's face, so that they are ready to receive the ball if it should be dropped. All the arrangements which cause the pillar to knock the ball out of the dragon's mouth are well hidden in the bottle. When an earthquake occurs, and the bottle is shaken, the dragon instantly drops the ball and the frog which receives it vibrates vigorously. Any one watching this instrument can easily observe earthquakes. With this arrangement, although one dragon may drop a ball, it is not necessary for the other seven dragons to drop their balls unless the movement has been in all directions : thus we can easily tell the direction of an earthquake. Once upon a time a dragon dropped its ball without any earthquake being observed, and the people therefore thought the instrument of no use, but after two or three days a notice came, saying that an earthquake had taken place at Ròsei. Hearing of this, those who doubted the use of this instrument began to believe in it again. After this ingenious instrument had been invented by Chôko, the Chinese Government wisely appointed a secretary to make observations on earthquakes." This, the most ancient of the whole class, is closely resembled by some of the instruments of modern times.

The Japanese have an instrument consisting of a magnet holding up a nail, which, when shaken off, starts the train of an alarum, but this does not seem to have ever acted with success. Other seismoscopes depend upon the overthrow of a round column of wood or metal, the projection of balls which are connected with electric circuits, or the disturbance of liquids. Some seismographs depend upon the motions of a pendulum, which may be made to show whether the direction of the shock has been constant or variable, and the maximum extent of its motion in various directions. Other instruments are formed by various adjustments of movable bodies, or with springs and adaptations of clock-work. For a complete seismograph we require three distinct sets of apparatus—an apparatus to record horizontal motion, one to record vertical motion, and one to record time. These principles are all embodied in the Gray and Milne seismograph, which is now in use in Japan. In this apparatus (Fig. 2) two mutually rectangular components of the horizontal motion of the earth are recorded on a sheet of smoked paper wound round a drum, D, kept continuously in motion by clock-work, W, by means of two conical pendulum seismographs, C. The vertical motion is recorded on the same sheet of paper by means of a compensated-spring seismograph, S. L. M. B. The time of occurrence of an earthquake is determined by causing the circuit of two electro-magnets to be closed by the shaking. One of these magnets relieves a mechanism, forming part of a time-keeper, which causes the dial of the time-piece to come suddenly forward on the hands and then move back to its original position. The hands are

provided with ink-pads, which mark their positions on the dial, thus indicating the hour, minute, and second when the circuit was closed. The second electro-magnet causes a pointer to make a mark on the paper receiving the record of the motion. This mark indicates the part of the earthquake at which the circuit was closed. The duration

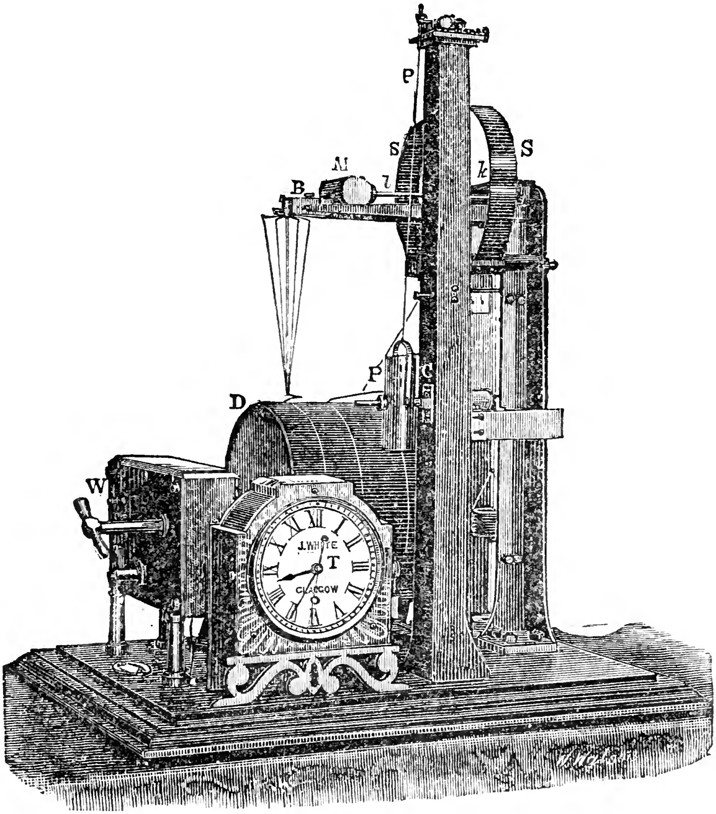


FIG. 2.

of the earthquake is estimated from the length of the record on the smoked paper and the rate of motion of the drum. The nature and period of the different movements are obtained from the curves drawn on the paper.

It may be said, as the result of experiences and observations, that an ordinary earthquake consists of a number of backward-and-forward motions of the ground following each other in quick succession. Sometimes these commence and die out so gradually that those who have endeavored to time the duration of an earthquake have found it difficult to say when the shock began and when it ended. Sometimes the motions gradually increase to a maximum and then die out as gradually; sometimes the maximum comes suddenly; and at other times

during an earthquake the observer's feelings distinctly tell him that there are several maxima. The chief results which investigators have aimed at have been the measurement of the amplitude, period, direction, and duration of the motions ; and attention has been given to the velocity with which the disturbance is propagated.

If we were to ask the inhabitants of a town which had been shaken by an earthquake the direction of the motion they had experienced, it is not unlikely that their replies would include all the points of the compass. Many, in consequence of their alarm, have not been able to make accurate observations. Others have been deceived by the motion of the building in which they were situated. Some tell us that the motion was north and south, while others say that it was east and west. A certain number have recognized several motions, and among the rest there will be a few who have felt a wriggling or twisting. Leaving out exceptional cases, the general result obtained from personal observation as to the direction of an earthquake of moderate intensity is extremely indefinite, and the only satisfactory information to be got is that derived from instruments or from the effects of the earthquake as exhibited in shattered buildings and bodies which had been overturned or projected. By the use of seismographs it has been shown that during an earthquake the ground may move in one, two, or several directions, and it is only when a decided shock is experienced that we can determine with any confidence the direction in which the motion has been propagated. The apparently twisting or wriggling motions are supposed to be the result of combinations of linear movements in different directions. It is often difficult, when reading accounts of earthquakes, to determine the length of time a shaking was continuous. Disturbances which succeed one another with sufficient rapidity to cause an almost continual trembling of the ground may be regarded as collectively forming one great seismic effort, which may last a minute, an hour, a day, a week, or even several years. Strictly speaking, they are a series of separate earthquakes, the vibrations of which more or less overlap. Whenever a large earthquake occurs, it is generally succeeded by a considerable number of smaller shocks. Disturbances of this character are compared by Mallet to "an occasional cannonade during a continuous but irregular rattle of musketry." Continuous motions perceptible to our senses without the aid of instruments usually last from thirty seconds to about two or three minutes. The principal vibrations or shocks of the disturbance occur at unequal intervals ; and in the periods of vibration there are irregularities in any given earthquake, and different earthquakes differ from one another. The extent of the movement is much less than the feelings of one experiencing a shock would lead him to estimate it. It is usually within the fraction of an inch in either direction. According to Dr. Wagener, the earth's horizontal motion at the time of a small earthquake is usually only the fraction of a millimetre, and it seldom exceeds three or

four millimetres. Mallet believes that the displacement may in some instances be equal to a foot; and M. Abella records a rough observation, in the Philippine Islands, of a motion of the earth to a distance of two metres, when fissures were formed, and seen to open and shut. The velocity of propagation of the wave may vary, even in the same country, between several hundreds and several thousands of feet per second. The same earthquake travels faster across districts near to its origin than it does across districts which are far removed; and, the greater the intensity of the shock, the greater is the velocity.

If we were suddenly placed among the ruins of a large city which had been shattered by an earthquake, it is doubtful whether we should at once recognize any law as to the relative position of the masses of rubbish and the general destruction around. The results of observation have, however, shown that, among the apparently chaotic ruin produced by earthquakes there runs more or less of law governing the position of bodies which have fallen, the direction and position of cracks in walls, and the other effects. Usually, walls of buildings at right angles to the shock will be more likely to be overthrown than those which are parallel to it. It is said that in Carácas every house has its *lado securo*, or safe side, where the inhabitants place their fragile property. It is the north side, and has been chosen because about two out of three destructive shocks traverse the city from west to east, so that the walls in those sides of the building take them broadside on. This appears to be the rule in destructive earthquakes. But, when a building is subjected to a slight movement, it is assumed that the walls at right angles to the direction of the shock move backward and forward as a whole, and there is little or no tendency for them to be fractured at their weaker parts. The walls, however, which are parallel to the direction of the movement are extended and contracted along their length, and may consequently be expected to give way over the door- and window-openings. The results of the examination of more than three hundred foreign-built brick houses in Tokio, Japan, all similar in their construction, are typically illustrated in Fig. 3. They show that in the upper windows nearly all the cracks ran from the springing of the arches, which formed an angle with the abutment. In the lower arches, which curved into the abutments, not a single crack was observed at the spring-way. The cracks in those arches were near the crown, where beams projected to carry the balcony; and in many instances they proceeded from such beams, even if there were no arches beneath. The houses which were most cracked were in the streets running parallel to the direction in which the greater number and most powerful set of shocks cross the city. From the fact that cracks once made in a building did not appear to extend under the repetition of shocks similar to the one that produced them, it has been inferred that buildings thus cracked acquire a degree of

flexibility, and that, by providing cracks or joints between the parts of buildings which have different periods of vibration, some of the strain might be taken off from them, and they might be made more stable. In stone-work, the cracks have been observed generally to run through the mortar-joints; in brick-work, through either bricks or mortar, often preferring the bricks.

As fractures in walls seem most likely to take place above openings like doors or windows, it follows that where architecture demands that openings should be placed one above another in heavy walls, there will be lines of weakness running through the openings. As arches are only intended to resist vertical thrusts, special construction must be adopted to make them strong enough to resist horizontal pulls. This might be given by inserting iron girders or wooden lintels in the arches. Mr. Perry, of Tokio, has suggested a plan of building so that the openings of each tier would occupy alternate positions. Such a line is shown in Fig. 4, where the dotted lines run through openings

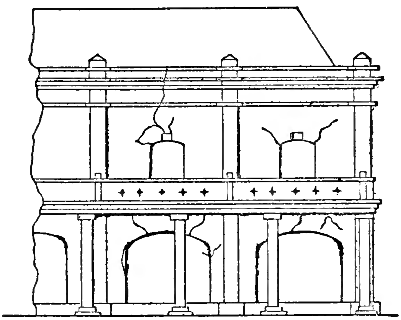


FIG. 3.—BRICK BUILDINGS IN TOKIO, SHOWING FRACTURES.

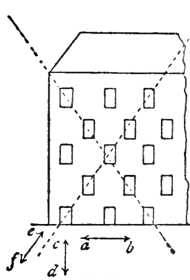


FIG. 4.

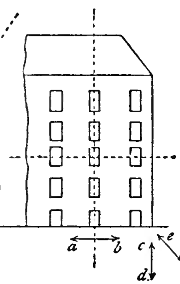


FIG. 5.

representing the direction of the lines of weakness. If we compare this with Fig. 5, we shall see that in the case of a horizontal movement, *a b*, or a vertical movement, *c d*, fractures would more probably occur in a house built like Fig. 5 than in one built like Fig. 4. If, however, these two buildings were shaken by a shock which had an angle of emergence of about 45°, in the direction of *e f*, the effects might be reversed. Fractures following a vertical line of weakness are shown in the accompanying drawing (Fig. 6) of the church of St. Augustin, at Manila, shattered by the earthquake of 1880.

When an earthquake shock enters and proceeds along a line of buildings, the last building in the row will, of course, suffer the most, and will exhibit the greatest tendency to fly away from its neighbors. If the house stands on the edge of a canal, or cliff, this tendency is increased by the similar motion of the escarpment. The fate of an end-building thus stricken is shown in Fig. 7, which is taken from the photograph of a house that was shattered in 1868 at San Francisco. Houses may also be rocked on their foundations, or even

quite overturned, as appears to have happened to the stud-mill at Hayward, California (Fig. 8).

In any building which may be affected by an earthquake, we have to consider the vibration of a number of parts, the periods of which, if they were independent of each other, would be different. On account of this difference in period, while one portion of a building is

Fig. 6.—Church of St. Augustin, Manila. Earthquakes of July 18–20, 1880.

endeavoring to move toward the right, another is pulling toward the left, and either the bonds which join them or the parts themselves will be strained or broken. This was illustrated by many of the chimneys in the houses at Yokohama, which, in the earthquake of February 20, 1880, were shorn off just above the roof. Since then, builders have learned to let chimneys pass freely through the roof without coming in contact with any of the main timbers.

In trying to make structures earthquake-proof, we may build our house weak and flexible, so that the shock shall pass over it as the wind over a reed, or we may attempt to make it stronger than the shock. The native Japanese houses, with their flexible framing, are built on the former plan ; some of the European houses essay the

latter. In Italy the houses are left to take their chances. In South America, where much exposed to earthquakes, they are built of only one story, or of bamboo and ropes, similarly to the Japanese plan. One of the safest houses for an earthquake country would probably be a one-storied, strongly framed timber house, with a light, flattish roof,

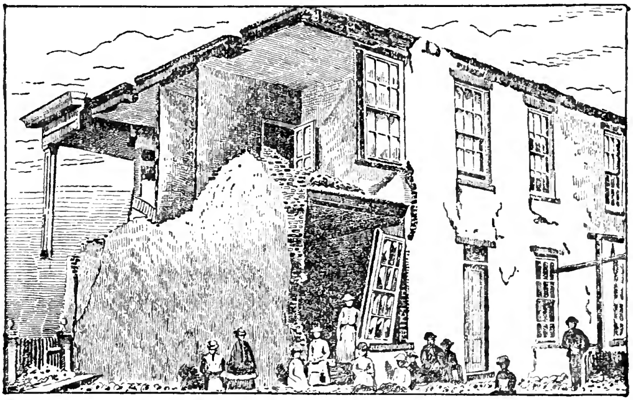


FIG. 7.—WEBBER HOUSE, SAN FRANCISCO, OCTOBER 21, 1868.

made of shingles or sheet-iron, the whole resting on a quantity of small cast-iron balls carried on flat plates bedded in the foundations. The chimneys might be made of sheet-iron, carried through holes free of the roof. The ornamentation ought to be of light materials. The nature of the ground on which the house is built does not always

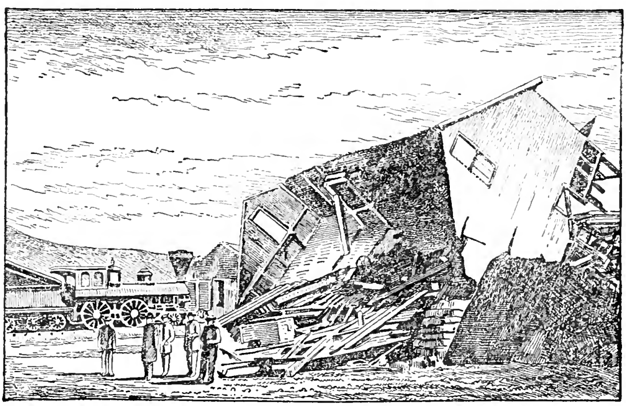


FIG. 8.—STUD MILL AT HAYWARDS, CALIFORNIA, OCTOBER 21, 1868.

appear to be in itself a matter of prime moment. Its relations with other foundations are more important. In some places solid strata, in others soft strata, appear to afford the more favorable situations; and the superiority of either probably depends on a variety of local circumstances. Places near the junction of the two kinds of forma-

tions are the worst. The progress of the wave may be interrupted by the interposition of a mountain-range or a hill, in which case we have behind the barrier the phenomenon called an earthquake-shadow; it may be cut off by a deep ditch, as a canal; and in certain parts of South America there appear to exist tracts of ground which are practically exempt from the shocks, while the whole country around is violently shaken. It would seem as if the shock passed beneath such a district as water passes beneath a bridge; and for this reason such tracts have been christened "bridges." In the Syrian earthquake of 1837, neighboring villages, and even neighboring houses, suffered differently. In one case a house was entirely destroyed, while in the next house nothing was felt. In Japan, at a place called Choshi, about fifty-five miles east of the capital, earthquakes are seldom felt, although the surrounding districts may be severely shaken. At this place a large basaltic boss rises in the midst of alluvial strata. The immunity of the district from earthquakes has probably given rise to the myth of the Kanam rock, which is a stone supposed to rest upon the head of a monstrous cat-fish, whose writhings cause the shakings so often felt.

Possibly something may be done in arranging the surroundings of buildings to ward off the destructive effects of earthquakes. The Temple of Diana, at Ephesus, was built on the edge of a marsh for this object. Pliny says that the Capitol of Rome was saved by the Catacombs. Elisée Reclus says that the Romans and Hellenes found out that caverns, wells, and quarries retarded the disturbance of the earth, and protected edifices in their neighborhood. The Tower of Capua was saved by its numerous wells. Vivenzis asserts that in building the Capitol the Romans sank wells to weaken the effects of terrestrial oscillations; and Humboldt relates the same of the inhabitants of San Domingo. Quito is said to receive protection from the numerous cañons in the neighborhood, while Lactacunga, fifteen miles distant, has often been destroyed. Similarly, it is extremely probable that many portions of Tokio have from time to time been protected more or less from the severe shocks of earthquakes by the numerous moats and deep canals which intersect the city.

Various causes have been assigned for the production of earthquakes, and, although they may all singly or in combination contribute to the effect, we must conclude, after considering the whole subject, that the primary cause is endogenous to our earth, and that exogenous causes, like the attraction of the sun and moon, and barometric fluctuations, play but a small part in the actual production of the phenomena, their greatest effect being to cause a slight preponderance in the number of earthquakes at particular seasons. The majority of earthquakes are due to explosive efforts at volcanic foci. The greater number of these explosions take place beneath the sea, and are probably due to the admission of water through fissures to the heated rocks

beneath. A smaller number of earthquakes originate at actual volcanoes. Some earthquakes are produced by the sudden fracture of rocky strata or the production of faults. This may be attributable to stresses brought about by elevatory pressure. Lastly, we have earthquakes due to the collapse of underground excavations; and these may have been produced by evisceration caused by volcanic eruptions, by the washing away or solution of the earth by chemically charged waters or hot springs, or by other causes.

Considerable attention has been drawn lately toward the study of small vibratory motions of the ground which, to the unaided senses, are usually passed by without recognition. They are called earth-tremors, and were only discovered when difficulties caused by them were encountered in the adjustment of extremely delicate astronomical and other instruments. These movements have been most carefully studied in Italy by Father Bertelli, of Florence; le Conte Malvasia, at Bologna; M. di Rossi, at Rome; and le Baron Puet, at Nice. Delicate instruments have been devised for detecting and recording them, the most important of which is the *normal tromometer* of Bertelli and Rossi. It consists of a pendulum (Fig. 9) one and a half metre long, carrying, by means of a very fine wire, a weight of one hundred grammes. To the base of the bob a vertical stile is attached, and the whole is inclosed in a tube, terminated at its base by a glass prism of such a form that, when looked through horizontally, the motion of the stile can be seen in all azimuths. In front of this prism a microscope is placed. Inside the microscope is a micromatic scale, so arranged that it can be turned to coincide with the apparent direction of oscillation of the point of the stile. In this way not only can the amplitude of the motion of the stile be measured, but also its azimuth. The extent of vertical motion is measured by the up-and-down motion of the stile due to the elasticity of the supporting wire.

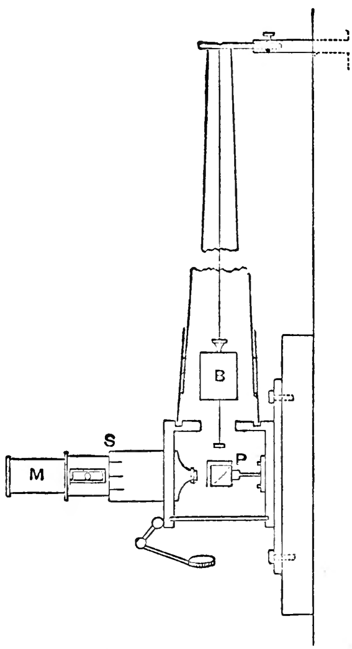


FIG. 9.—NORMAL TROMOMETER. B, bob of pendulum; P, prism; M, microscope; S, rim of scale.

Another instrument, the *microseismograph* of Professor Rossi, gives automatic records of slight motions. It consists of four pendulums, each about three feet long, suspended so that they form the corners of a square platform. In the center of this platform a fifth but rather

longer pendulum is suspended. The four pendulums are each connected just above their bobs to the central pendulum with loose silk threads. Fixed to the center of each of these threads, and held vertically by a light spring, is a needle, so adjusted that each thread is depressed to form an obtuse angle of about 155°. These needles form the terminals of an electric circuit, the other termination of which is a small cup of mercury placed just below the lower end of the needle. By a horizontal swing of one of the pendulums this arrangement causes the needle to move vertically, but with a slightly multiplied amplitude. By this motion the needle comes in contact with the mercury, and an electro-magnet with a lever and pencil is caused to make a mark on a band moved by clock-work. The five pendulums being of different lengths, the apparatus is adapted to respond to seismic waves of different velocities.

Professor Rossi's *microphone* consists of a metallic swing arranged like the beam of a balance. By means of a movable weight at one end of the beam, this is so adjusted that it falls down until it comes in contact with a metallic stop. The beam and the stop form two poles of an electric circuit, in which is a telephone. The slightest motion in a vertical direction causes a fluctuation in the current passing between the stop and the beam, and announces itself in the telephone.

By observations made with instruments like these, it has been shown that the soil of Italy is in incessant movement, with periods of excessive activity, called seismic storms, that usually last about ten days. The storms are separated by periods of relative calm. They are more regular in winter, and exhibit sharp maximums in spring and autumn. In the midst of such a period or at its end there is usually an earthquake. They have been observed to be generally related to barometric depressions.

Earth-pulsations are slow but large undulations that appear to travel over or disturb the surface of the globe. They are made manifest through variations in the movement of pendulums, changes in the position of the bubbles of levels, eccentricities in the behavior of clocks, the swinging of chandeliers in churches, unusual disturbances in bodies of water, and even of water in tubs, irregularities in the flow of springs, and other phenomena, the occurrence of which, or the peculiar manner of it, while it is consistent with the hypothesis of such movement, can not be accounted for on any other probable supposition.

AN EXPERIMENT IN SILK-CULTURE.

By MARGARETTE W. BROOKS.

IN an article on silk-culture, published in "Harper's Magazine" more than a quarter of a century ago, the following passage occurs: "We shall soon be ready to begin that which the next century will find us doing with all our might—commanding the silk as we now do the cotton markets of the world." When we consider how little has been accomplished since that time, it is to be feared that this prophecy will not be realized unless greater advances are made in the next twenty-five years than were made in the last. Repeated trials seem only to show that silk-raising in the United States is not as profitable an industry as it was formerly thought to be.

The culture of silk is so old that we can not tell when it was begun, or by whom it was first discovered. The Chinese claim that it was known to them as early as 2600 B.C. Almost all Roman and Greek authors mention it, but it was probably unknown in Europe until the sixth century after Christ, and not until the sixteenth century was it successfully started in France.

In the year 1714 the manufacture of silk was begun in England. James I tried to establish it in Virginia; and in Georgia in 1732 lands were granted on condition that on every ten acres of cleared land one hundred white mulberry-trees should be planted, and, on the seal of that State, silk-worms in various stages of their growth were represented. Two or three years later the first export, consisting of eight pounds of raw silk, was sent to England, and the silk manufactured from it was presented to the Queen. In the year 1759 ten thousand pounds were exported, but after the introduction of cotton the culture of silk declined, and the last exportation from Georgia was made in 1790.

In the year 1771 Pennsylvania and New Jersey began the culture of silk, and experiments were also tried in New York and other States. In an old newspaper, under the date of 1786, we read, "Late Philadelphia papers mention, as an extraordinary circumstance, that a family in Maryland have upward of two thousand silk-worms at work."

The Revolution put an end to silk-raising for a time, but in the early part of this century the culture of silk was again started in a number of States, among others in Louisiana and South Carolina, and even before this one of our New England States—Connecticut—began the culture of silk. In the year 1790 it was said that fifty families in New Haven were raising silk, and in a newspaper for the year 1787 we read that "a young miss in New Haven will soon wear a silk gown of her own make." In the same paragraph the hope is expressed that

soon it may be "esteemed disreputable, by both ladies and gentlemen, to wear any thick silk but of our own manufacture."

In 1819 five tons of raw silk were raised at Mansfield, Connecticut, and the manufacture of silk is still carried on there. In the year 1835 we read of a company formed in Rhode Island having a large plantation of about thirty thousand mulberry-trees, and the State Legislature of that year offers a premium of fifty cents on every pound of silk raised and reeled in that State within two years from the passage of the act. "Rhode Island is likely," so the paper says, "to take the lead in the manufacture of silk as she did in cotton.

That the interest in the culture of silk must have been kept up, for a time at least, is shown by the fact that in 1840 the United States exported 61,552 pounds of raw silk, and in 1844 396,790 pounds, but in 1850 only 14,763 pounds were exported, while in 1870 the census gives no statistics of silk raised in this country.

About 1860 the culture of silk was started in California, where the conditions of climate seemed specially favorable for its success, and for some years it was carried on; but by 1878 it had greatly declined, owing possibly to commercial and industrial depression. Whether the industry continues to any extent we have not ascertained.

In the year 1882 the Department of Agriculture received many letters from persons interested in the culture of silk, and distributed a few silk-worm eggs, but there was no general distribution.

In 1884 the department appropriated fifteen thousand dollars for the encouragement of the industry, and a special agent was appointed to attend to the work, the department offering to send eggs to any one who would try the experiment of raising them. I should judge, however, that no very favorable reports were received, as, at a meeting of the American Association for the Advancement of Science, in 1885, as reported in "Science," Professor Riley stated that the culture of silk had been tried in the United States for fifty years, and all that the experiments had shown so far was that silk could be raised over three fourths of the United States if there was a market for the cocoons. He considers the industry best conducted on a small scale, and adapted for women and children who have no other way of earning money. The profit for three persons he estimates at fifteen to twenty-five dollars for the season, provided the cocoons bring one dollar a pound—a price, by-the-way, which only the best cocoons bring.

The care of silk-worms is decidedly wearisome, interesting though it may be; and certainly any woman enterprising enough to start in the experiment of raising silk, and strong enough to do the necessary work, might find some more profitable way of utilizing her time.

Mr. Edward Atkinson, at the same meeting of the Association above mentioned, maintained that the culture of silk in the United States was not desirable, since there was no lack of employment, as the high rate of wages shows, and we can not afford to do for our-

selves what foreign laborers will do cheaper ; and, moreover, the raising of silk has always been carried on by the poorest and most inefficient peoples, who, as they rise in the social scale, abandon it, as is now coming to be the case in Southern France—France being unable to compete with the cheap labor of China and Japan. It may be added that another reason for the decline of silk-culture in France is said to be due to climatic changes.

One spring my attention was called to an article on silk-culture in which it was stated that silk could be successfully and profitably raised in the United States. The article then went on to quote from a manual written by a young girl, who had tried silk-raising and had been very successful. By a strange coincidence, in a few days a friend offered me an ounce of silk-worm eggs which she had just received from the Department of Agriculture at Washington. Not having the time, and possibly the inclination, to raise the worms herself, she kindly gave them to me, and I determined to try the experiment of raising silk-worms in one of the New England States.

During three or four months of cold weather the eggs were kept in a cool place in a cellar, at as even a temperature as was practicable, the thermometer rarely, if ever, going below freezing-point, and never rising above forty degrees.

The mulberry-tree, upon which the worm feeds, is one of the last trees to leave out in the spring ; but soon after the 1st of June the leaves began to show themselves, and on the 11th of June the eggs were placed in a warm room, where, on the 13th, they had begun to hatch. Only a few worms appeared that day ; the two following days there were more, and on the 16th and 17th great numbers appeared. It is estimated that there are forty thousand eggs in an ounce, but only between two and three thousand of my lot hatched. However, a number of the eggs had been given away, and probably some were unfertilized, or had been killed.

Then began the task of keeping the worms supplied with food ; and, fortunately, I had found a friend willing to undertake the experiment with me, for a task it indeed proved. The white mulberry is not common in Salem, and the nearest tree was nearly one quarter of a mile from the house, and often we went a greater distance for the leaves. At first a small number of leaves were sufficient, but in a week or two my friend and myself had all we could do to keep the worms, which were growing rapidly, supplied with fresh leaves ; then, too, the lower branches of the tree, which was a large one, were soon stripped, and some one had to climb the tree for us. Fresh leaves had to be picked every day, sometimes twice and even three times a day. This in itself took some time, and, if the leaves were at all damp, they had to be wiped or dried in some way before filling the trays.

The trays in which the worms were kept had to be very carefully cleaned, and all the refuse removed every day. As the worms grew

larger they, of course, needed more space, and our room was gradually filling with extemporized tables and shelves covered with trays. The cleaning of one tray seems a small matter, but when there are over fifty trays to clean and fill with fresh leaves it takes a good while, and often we did not get to bed until midnight. As early as possible in the morning we were again at work feeding the worms, and for thirty days we were kept incessantly employed, oftentimes feeling discouraged, as the leaves were hard to get and the weather hot and debilitating. Still, we were determined to do the best we could, and so persevered in our self-imposed task.

Thirty days from the time of hatching, having lost no worms by disease, the spinning of the first cocoon was begun, and a relief it was to see a large worm crawling restlessly around the edge of the box leaving traces of silk in the corners. Two days later the worms were spinning in earnest, and we found our work of feeding and cleaning somewhat lessened. We tied together twigs and straw, upon which the worms made their cocoons. Following a friend's suggestion, we begged from a grocer some of the straw coverings of wine-bottles, and these the worms seemed to like very much. The room now presented a very different appearance from that which it had a week or two before. Instead of the rows of boxes, the tables were covered with straw tent-like arrangements upon which were the yellow cocoons.

Before all had finished spinning, we thought it time to steam a part of the cocoons, and here we met with our first difficulty. None of the books on the subject, which we had at our disposal, gave any very definite ideas as to the method by which this part of the work might be accomplished.

Finally, after considerable perplexity, we made arrangements to have the steaming done at a boiler-room. We laid about eight hundred of the cocoons on a layer of cloth netting in a large box, at one end of which a hole had been made and a round gas-tube inserted. To this tube was attached a pipe from the boiler, and for twenty minutes, the time specified in a report published by the Department of Agriculture, the steam was allowed to enter the box. At the end of that time we found to our dismay that many of the cocoons had been blown to one end of the box, forming a sticky mass. If we had been almost discouraged before, we certainly were discouraged now. However, we dried them in the sun, and a few were sent to the Woman's Silk-Culture Association in Philadelphia, with a letter, asking whether we had steamed them too much, and for information in regard to steaming the rest, of which we also inclosed a sample. In answer to our request, a printed circular containing general directions was sent to us, but no special directions as to steaming the others ; but we were informed that our worms had been insufficiently fed ; the cocoons were small, and steamed too much ; and the fresh cocoons could not be reeled.

As there is but little market for cocoons in this country, all attempts to reel the silk here having been unsuccessful, we had not expected to realize much from the sale of the cocoons, still to be told that they were absolutely worthless was rather disappointing after our six weeks of hard work. We decided, however, to have the rest of the cocoons steamed, and these we did ourselves in a common steamer, and very much nicer they looked than our first lot.

But what was meant by our worms being insufficiently fed was not understood, and again we applied to the Woman's Silk-Culture Association for information, and this time we received a more satisfactory answer, though it seemed that our worms, instead of being underfed, may have been overfed, for the letter said they must not be fed while molting, and our worms had been fed at these periods. The "Report" gave the same information, but we understood the reason to be simply that time might be saved if worms of the same age could be made to molt together. But we found it difficult and well-nigh impossible to make them all molt at the same time, so finally were compelled to give them leaves as usual, supposing that those worms molting would not eat unless they needed food. In everything else we followed the directions given in the "Report" as nearly as possible. The worms certainly had plenty of room, fresh air, a uniform temperature, and as to the last requisite mentioned in the book—namely, cleanliness—we are sure that that condition at least was rigidly complied with, the trays being cleaned every day, and sometimes even oftener if it seemed necessary.

The room in which the worms were kept was on the northern side of the house, and had one northern and one eastern window, and a fireplace in which a fire was made whenever the weather was a little cool or damp, so it was comparatively easy to regulate the temperature.

In the second letter received from the Woman's Silk-Culture Association we were told that no one could expect to make anything from silk-raising until after two or three years' experience, and yet many papers speak of silk-raising as an employment, perhaps not very profitable, still a light employment for children and old people who can earn money in no other way. For farmers' wives this industry is also recommended, though where the ordinary farmer's wife is going to find the time for the business, coming as it does in the middle of the summer, when her work is heaviest, is not explained. One would think that any woman who could take care of silk-worms might earn more money in the same time raising chickens, selling eggs, or in light gardening, than by the sale of cocoons. Of course, like everything else, it requires skill and more especially experience, but there are few light employments that would not bring in a little money even the first year. To be sure, the outlay in the beginning is small; but had our cocoons been the ordinary size, and suitable for reeling, we could not, at the price cocoons are now bringing, have received more than

five dollars to pay us for the time spent in taking care of the worms during six weeks of intensely hot weather. Our expenses, not counting the cost of the fuel burned, amounted to over one dollar and fifty cents.

That others have had somewhat similar experiences is shown by the following extracts from recent newspapers. From Springfield, Massachusetts, a lady writes that, although she had but about eight hundred silk-worms, they kept her very busy during the last molt picking leaves, and she should not advise any one to engage in the business unless one is willing to work, for it is not an employment for lazy people. In return for her cocoons, which she sent to the New York Silk Exchange, she received a silk handkerchief and some embroidery floss made from her own cocoons, valued at about one dollar and twenty-five cents, which she thought "poor pay for six weeks' work." Her expenses, not counting time and labor, amounted to one dollar and sixty-three cents.

A widow in Ohio thought that the culture of silk might prove a pleasant and profitable way of supporting herself and two children; but after some expense and "six weeks of hard work, Sundays and all, found that she had not made a dollar by the operation."

From the "Massachusetts Plowman" the following extract is quoted: "Silk-culture requires a very close, unremitting attention on the part of those engaged in it, and if the work is not laborious it is so constant as to prevent the following of any other occupation at the same time. Those who desire to engage in sericulture will do well to consider thoroughly the matter."

One thing I can say in regard to the experiment, it is interesting work, though, whether it would be so to a person not interested at the outset in such matters I can not say; and, besides, it keeps one so busy that the interesting points are often overlooked. Yet I am sure that numerous friends who saw the worms in their different stages thoroughly enjoyed them, and it was of some account certainly to have interested so many people in a subject of so much importance. How many children, and I may say older people as well, never knew before that a moth came from a caterpillar, or that a worm formed the cocoon from which all our silk is made!

THE INFLUENCE OF EXERCISE UPON HEALTH.

By Professor EUGENE L. RICHARDS,

OF YALE COLLEGE.

MANY old theories of education are being mercilessly discussed. Many new theories claim the places of the old. The classical scholar still claims for the ancient languages the greatest educational power. The advocate of modern languages says life is too short to

study dead things, and that modern languages furnish enough discipline, and are, besides, useful. To the scientist, science is god of all, even of education. To him no man is properly educated unless his mind is stored with scientific ideas and trained by the scientific methods of the nineteenth century. Languages, ancient and modern, mathematics, science, philosophy, all advance their claims to be the best educators of the coming man. Meanwhile the coming man is nothing but a child, and must submit himself to his elders to be experimented upon according to the theories of teachers or parents.

For men, women, and children alike, I wish to enter a plea for a part of them much neglected in most discussions on education, and too much left out of sight in most theories of education—the body. In fact, for centuries past, many educators have seemed to regard the body as a rival of the brain, if not an enemy of it. They have apparently been filled with the idea that strength and time given to the body are strength and time taken from the mind. Unfortunately for the cause of good education, this erroneous idea is not held by teachers alone, but is a very prevalent one generally, the current dictum being that, representing by unity a person's force, whatever part of this unit is taken for the body leaves necessarily just that much less for the mind.

To combat this idea, and to replace it by a much more reasonable idea, I had almost said by the *very opposite idea*, shall be the chief though not the only aim of these pages.

To all races which have shown power in any direction the main source of that power has been physical. This is acknowledged to be true with regard to the conquering races of the past. With regard to the present we are too apt to think that the progress of civilization has changed the conditions of power, so that races physically weak, if they are only wise, can successfully compete with and finally overcome the strong races.

Take the Greeks. For a long time they were a conquering race—masters of the world of their time. But their influence has extended far beyond their day and beyond the limits of their little world. "It is no disgrace to a nineteenth-century American to go to school to the Greeks. They are still, in their own lines, the leaders of mankind. They are the masters." "Attica was about as large as Rhode Island. Rhode Island is a noble little Commonwealth. Yet it has enjoyed political liberty longer than the democracy of Athens lasted, and in the midst of the blazing light of this much-lauded century. What now is or will be the influence of Rhode Island on the world's history compared with the unmeasured and imperishable influence of Athens? Whence the difference?" * The causes of the difference were manifold. One cause was their physical education. Hand in hand with their mental discipline, which was simple but thorough, went gymnastic exercise. "Until the time of Alexander, the main

* Professor George P. Fisher, "Princeton Review," March, 1884.

subjects of education among the Greeks were music and gymnastics, bodily training and mental culture. . . . The first duty of a Greek boy was to learn his letters, a feat which was also coincident with learning to swim. . . . By the fourteenth year the Greek boy would have begun to devote himself seriously to athletics."* Could such a careful and continuous training of the body fail to have its effects upon the mind? It gave the body power. It gave the brain force. Had this force not been converted all the while into intellect and æsthetic sense, the Greeks would have formed a race of fine animals only. But their mental discipline saved them. Unfortunately for the permanence of the Greek power, that power was not built upon a moral basis. When, by means of their conquests, wealth and luxury came to them, the Greeks met the usual fate of nations weak in the moral sense. Their discipline was relaxed, and they succumbed to the strong.

The training of the Romans was largely physical. They were trained for war. But they, too, were overcome by stronger races when they relaxed their own discipline and gave up their martial games and athletic exercises — hiring gladiators for their sport and mercenaries for their battles.

What are the conquering races of to-day? Are they not the nations strong in body—strong by inheritance and keeping their strength by exercise? Germany keeps her men strong in the army by compulsory gymnastic drill. Her schools teach gymnastics. Many of her inhabitants in the cities maintain their strength by the exercise which they have in their excellent Turner system.

England has in the bodies of her children the blood of those old rovers who were the terror of the coasts of Europe in the early centuries of the Christian era, mixed with the blood of that vigorous native stock, to subdue which, even when furnished with only barbarian arms, was no easy task to the Roman legions with all their military skill. In England, too, this physical force is still maintained by vigorous exercise taken by all classes. The higher classes have their out-of-door sports, and some of them of the roughest kind. The lower classes also have their sports. Wherever the English race goes it carries with it the love of exercise and the practice of it. Even their women engage in it. Some of them follow the hounds. They pull the bow. They take walks, the length of which would shame many an American man. So the vigor of the stock never decays. The race increases and multiplies. The little island can not hold it. Away it goes to conquer and colonize the globe, and to infuse its strength into all the races of the earth.

What keeps us as a nation from deterioration? The bone and sinew of the land—the cultivators of the soil—the conquerors of our new land —the men who build our cities and the great highways between them, who dig our coal and labor with hand and body in all our factories.

* "Educational Theories," by Oscar Browning.

It is true that brain directs all this activity, but muscle is the motive-power. And the muscle of one generation is the source and support of the brain-power of the following generations. "What else accounts for the prodigal activity" * of the descendants of the early settlers of this country, but the fact that obliged, when cast on a land like ours, to battle with the elements and conquer the forests by their own bodily strength, they lived an out-door life in the main, and stored up an immense "capital of vitality" which they handed down to their posterity? Some of that posterity are not content to use the interest of that capital, but are spending the principal. What is the consequence? Not only enfeeblement of body and mind, but sterility; and thus, many of the old New England families are dying out in the homes of their race, and are giving place to the strong new-comers.

As to individuals, what kinds of men fight their way to the front ranks in all callings, and hold their places there, as men eminent in their day and generation? Men of strong body. Consider the premiers of England—men like Brougham, Palmerston, and Gladstone—working at an age when many a weaker man would either be in his grave or be preparing for it! Some exercise—horseback-riding or felling trees—keeps up their strength long after threescore and ten. It is only necessary to mention Washington, Jackson, Webster, and Lincoln, to call attention to the fact that among eminent American public men vigor of mind and vigor of body go together. Notice the great pulpit orators of to-day—such as Spurgeon, Beecher, John Hall, and Phillips Brooks. Among moneyed men, did not Commodore Vanderbilt owe something of his vast fortune to his strong body? Could he have endured the strain of building that fortune, and would he have had the vigor to extend it, had it not been for the out-door life of his early manhood? If you find a really successful man, who builds and keeps either a reputation or a fortune by honest hand work, he is generally a man of vigorous body. "All professional biography teaches that to win lasting distinction in sedentary in-door occupations, which task the brain and nervous system, extraordinary toughness of body must accompany extraordinary mental power." † Again, "To attain success and length of service in any of the learned professions, including that of teaching, a vigorous body is well-nigh essential." ‡

It would be out of place to advise a farmer who is already tired of digging and plowing, or a mason who has had enough of bricklaying, to exercise his body. A little play to limber the stiffened muscles might be a good thing. A little brain-work might be better. But of real hard-working exercise of body each working-man gets enough from his day's labor. If he only get good food and enough of it, and have time for sufficient sleep, and get pure air to breathe, and clean water to drink and to bathe in, he will do well enough, as far as bod-

* S. Weir Mitchell, in "Wear and Tear."

† President Eliot, in "Annual Report for 1877–'78."

‡ President Eliot.

ily health is concerned. But to brain-workers and to all persons of sedentary habits it can be truly said that vigorous exercise of the entire body is not only advisable if they would enjoy health, but that it is absolutely essential to that life. The London "Times," of December 11, 1882, records the physical and mental deterioration which has fallen on the civil servants of India, described by an Indian correspondent: "Since the institution of competitive examinations, out of a hundred-odd civilians nine have died and two have been forced to retire on account of physical debility. Ten more were considered quite unfit for their work on account of bodily weakness, and eight have positively become insane."* Here is a record of twenty-nine out of a hundred persons physically deficient. The hundred belonged to one of the strongest races of the earth. Does not the fact testify to the great demands of civilization on the vitality of the people of modern times? But it will be replied that the climate of India had something to do with the facts. Well, read what Dr. E. H. Clarke says of our country: "No race of human kind has yet obtained a permanent foothold upon this continent. Mounds at the West, vestiges in Florida, and traces elsewhere, proclaim at least two extinct races." "The Indian whom our ancestors confronted was losing his hold on the continent when the Mayflower anchored in Plymouth Bay, and is now also rapidly disappearing. It remains to be seen if the Anglo-Saxon race, which has ventured upon a continent that has proved the tomb of antecedent races, can be more fortunate than they in maintaining a permanent grasp upon this Western world. One thing, at least, is sure: it will fail, as previous races have failed, unless it can produce a physique and a brain capable of meeting successfully the demands that our climate and civilization make upon it."† Read the following facts with regard to Chicago: From 1852 to 1868, population increased 5·1 times what it was in the first peried. The death-rate increased 3·7 times. The deaths from *nervous* disorders increased 20·4 times.‡ Chicago is perhaps a fast place, but the figures are significant of the wear of city life on the nervous system.

Is not this strain of the nervous system a peculiarly American danger? To be sure, all brain-workers in all countries are liable to it, but in our country climatic influences increase the tendency. Under these influences we have developed national characteristics, showing in form and feature. We do things in a hurry. We are in haste to get rich. We are in haste to be wise. We have no time for exercise. We have no time for play. Both exercise and play are by serious people often looked upon as a waste of time for adults, however good they may be for children and young people. A boy must be a man before his time, and a girl must be prim and staid, and must not romp like her more

* Bonamy Price, in "Princeton Review," July, 1884.

† "The Building of a Brain," Dr. Edward H. Clarke.

‡ "Wear and Tear," Dr. S. Weir Mitchell.

fortunate brothers, but must be a sober woman after she has entered her teens. It seems as if the battle of modern life (at least of modern city life) was a battle of the nerves. "From nursery to school, from school to college, or to work, the strain of brain goes on, and strain of nerve—scholarships, examinations, speculations, promotions, excitements, stimulations, long hours of work, late hours of rest, jaded frames, weary brains, jarring nerves all intensified by the exigencies of our school and city life." * The worst of the mischief is, that this strain falls most of all upon those from nature and circumstance least able to bear it—upon our women. Public opinion frowns upon their exercising like men. Yet, with a nervous system more sensitive than man's, they need the very exercises (out-of-doors) which, by a mistaken public sentiment, they are often forbidden to take. The healthy house-work is often deputed to a servant either because too hard for our American girls, or too much beneath them.

Of the five agents of health—exercise, food, air, sleep, and bathing—exercise, to a certain extent, regulates the demand for the other agents. The muscles, when fully developed, constitute about a half of the full-grown body. The muscular contractions act upon the blood. The blood is the life-stream, carrying the atoms of nourishment to every part of the body, and receiving the waste particles which have already done their work. This process of depositing building substance and receiving waste matter goes on according to a law. This law, called, from its discoverer, the law of Treviranus, is—"Each organ is, to every other, as an excreting organ. In other words, to insure perfect health, every tissue, bone, nerve, tendon, or muscle, should take from the blood certain materials and return to it certain others. To do this, every organ must or ought to have its period of activity and rest, so as to keep the vital fluid in a proper state to nourish every other part." † So that, if we give to the muscles their share of labor, as indicated by the ratio which they bear to the whole body, according to this law, we ought to give a large proportion of our waking hours to their use. But there are certain involuntary muscles doing their work all the time, night and day. In our usual vocations, too, however confining they may be, we are obliged to take a certain amount of muscular exercise. Consequently, in the really necessary work of any ordinarily busy person, the muscles do have a fair share of exercise. Still, there are a number of muscles which are used almost exclusively, so that other muscles, with their connecting tendons, bones, and nerves, fail, from sheer neglect, to contribute to the health of the whole body. How many women exercise fully the large muscles of the back and loins, or the muscles of the abdomen? Women who wash, or those who work in field or garden. Yet these important muscles, when used, contribute much not only to the health of the body in general, but also to the vigor of the organs lying underneath

* "Physical Training," McLaren. † "Wear and Tear," S. Weir Mitchell.

them. So, too, in walking, how few use the muscles of the calf of the leg? Most people merely stamp along the path or road. They do not use the foot from heel to toe. They fail to rise on the toes at the end of the step, and do not push themselves along with those important members of the foot. Thus they lose the best part of the leverage of that important muscle or set of muscles of the lower leg. The fault is frequently in the shoe of the walker. That has too high a heel, and pinches the toes, making any movement of them painful, even if it does not prevent them from moving at all.

By making regular daily use of the muscles—of all the muscles, if that were possible—we should do one thing toward establishing perfect health of body by allowing to one very large part of it a fair chance to appropriate its proper elements from the blood, and opportunity to give back its used-up tissue to be eliminated from the system in natural and healthy ways. We should be doing more than simply repairing the muscles. We should be also evolving heat—a very important factor of life. We should be assisting all the other parts of our organization to do their work.

Take the heart—itself a very bundle of muscular fibers. We know that as long as we live, whether sleeping or waking, that wonderful organ keeps up its regular contractions and expansions. But, when we use our muscles, their contractile force upon the blood-vessels helps the blood along its channels, and thus takes a little labor from the propelling heart. It beats faster but with less effort.

While helping the heart, muscular exercise helps the lungs also. More exercise means for the lungs more breath; that is, more air inspired, and more carbonic-acid gas expired. By deeper breathings the involuntary muscles are strengthened. Moreover, we are made to feel the need of greater lung-room. Even after the age when full stature is supposed to be attained, that lung-room often comes, Nature furnishing the supply according to the demand. McLaren notes the case of one man, in his thirty-sixth year, whose chest, under systematic exercise, increased in girth from thirty-two to thirty-six and a half inches in *two* months. There was an addition of four and a half inches to the circumference of the chest. "An addition of *three* inches to circumference of chest implies that the lungs, instead of containing 250 cubic inches of air before their functional activity was exalted, are now capable of receiving 300 cubic inches into their cells."* This great increase, of four and a half inches, meant not only increase of lung-room, but increase of lung-power.

Taking the quantity of air inspired in the reclining position in a given time as the unit	1
In the same period of time the quantity of air inspired when standing is	1·33
When walking one mile per hour, is	1·9
When walking four miles per hour, is	5
When riding and trotting, is	4·05
When swimming, is	4·33 †

* "University Oars," Dr. Morgan.

† "Health," Dr. Edward Smith.

While the lungs and heart are doing better work under the stimulus of muscular exercise, the heart pumping the blood more certainly to the farthermost tissue of the body and the lungs more rapidly purifying the blood, other organs are benefited. The diaphragm, that muscle separating the lungs and heart from the stomach and liver, is rising and falling, and, with the increased expansion and contraction of the walls of the thorax, is moving all the contents of the abdomen to activity. The liver, the great gland of the body, has not only more blood sent to it, but is quickened to action. For bilious people there is no medicine like exercise and fresh air. In malarial districts, bilious people are most easily affected by the malarial poison. Though in such districts a great many troubles are conveniently laid at the door of that enemy of health which do not justly belong there, yet of the fact that some are affected by it, and others equally exposed are not affected by it, may not the explanation be, that an active circulation in one person effects the elimination of the poison through the excretory organs so rapidly that it can not collect in sufficient quantities to cause disturbance of the system? In the case of a person affected by a stupefying poison, the first thing to be done is to keep the individual moving; that is, to keep the circulation going by exercise till the poison can be eliminated. The laboring-man who works at a sewer in front of a house seldom feels any ill effects from the overturned soil and poisonous gas, while some dweller in the house, apparently not so much exposed, is stricken with typhoid or malarial fever. Causes of the immunity of the workman may be found in his greater strength and feebler sensibility, and in his open-air life; but may not another reason be seen in the quickened action of his lungs and the profuse perspiration of his skin? As to the effect of want of exercise on the liver, the following passage may be quoted from an authority on the subject: "A want of exercise in the open air leads to derangement of the liver in two ways: viz. (*a*) By causing a deficient supply of oxygen to the system, as a result of which the oxidizing processes, which go on in the liver and elsewhere, are imperfectly performed, and there is a tendency to the accumulation in the system of fat and the imperfectly oxidized products of disintegrated albumen. Oxygen is, so to speak, the antidote for the destruction of *materies morbi* (lithic acid, etc.) produced by imperfectly oxidized albumen. (*b*) By retarding the circulation of the blood through the liver. Since the time of Haller (1764), physiologists have recognized the influence of the respiratory movements in producing the circulation of blood through the liver; but upward of thirty years ago Mr. Alexander Shaw showed more clearly than ever before that the circulation of blood through the liver was greatly influenced by the alternate expansion and contraction of the thorax during respiration. Mr. Shaw called attention to the fact that the portal vein, without any provision for increasing its power, 'has to perform

the duty usually fulfilled by an artery.' He suggested that this weak power, by which the portal vein propelled its blood, was compensated for by a suction force communicated to the current of the blood by the actions of respiration. These reasonings have been confirmed by certain experiments of M. Bernard." "In persons, then, who lead a sedentary life, this auxiliary force for promoting the circulation of blood through the liver is diminished, blood stagnates in the gland, and the functions of the organ are deranged, these results being all the more likely to arise if the liver be at the same time over-stimulated by errors in diet." *

Take another organ. The stomach is a muscular organ, being furnished with bands of muscular fiber, which squeeze and press the food, turning it over and over, so that it may be the better permeated by the juices which digest it. It, too, is stimulated by exercise, especially by an exercise like walking or riding, which increases its movement. This motion makes easier work for the organ and increases its activity. It increases its activity also in another way, by demanding more of it. For increased work by any part of the body means increased destruction of tissue. "To repair the waste is the office of the blood, as the distributor of the material to be supplied. The main furnisher of this new material in the right form to do its work is the stomach. For food is both the fuel which keeps our bodily machinery going and the material by which the machinery itself is repaired. The stomach, with the duodenum, is the place where all this material is prepared to do its work in the most economical way. More exercise, then, means more waste, more waste means more repair, and more repair means a greater demand for food and water. The more, then, we waste any part of the body by exercise (within certain limits), if there is due repair, the better off is that part. The strength of the body, as a whole, and of each part of the body individually, is thus ever in relation to its newness." †

The bowels, too, the great sewers of the bodily system, inclosed in pliable walls needing constant motion and fresh supplies of blood for their healthy exercise, feel the action of the breathing lungs, and are sensible of every turn, twist, rising, and falling of the body. Deprive the body of exercise, and you deprive the bowels of blood and proper action, and bring in a long train of evils, a catalogue of which can be read in the advertising columns of almost any daily newspaper.

The kidneys, too, are affected by physical exercise. Doubtless they receive a certain stimulation from the motion communicated to them in exercise, but as they are engaged in the work of eliminating from the system its excess of liquid with certain effete matter in solution, and as the skin is also concerned in a similar work, they are affected by exercise mostly with reference to this joint action. The more active the skin is, the less work the kidneys have to do.

* "Functional Derangements of the Liver," Murchison.

† McLaren.

To realize more definitely the work which the skin does, consider the fact that a square inch of skin is calculated to contain twenty-eight thousand pores. These pores, if healthy, are at all times purifying the blood by insensible perspiration, and in times of vigorous exercise make that perspiration very sensible. This sensible perspiration is essential to health, for the pores must occasionally be opened wide and flushed, in order to cleanse them thoroughly. Not only is this action of the skin in exercise increased by the increased flow of blood to the surface, but also by the mere motion of the muscles under the skin. This last effect might be called the direct effect of exercise on the skin. How close this connection is between the skin and muscles may be seen from the fact that "any part of the skin of the hand is in connection with, perhaps, two hundred muscles." This "fact, showing the exceedingly numerous and complicated communications between a given portion of the skin and the moving organs," * makes it easy to conceive how the skin is stimulated to action directly by exercise.

Bodily exercise is essential to the healthy action of the brain and the nerves. There is no real conflict between brain-work and body-work. Brain presupposes body; can not exist without it; is dependent upon it for support and nourishment. Brain can not communicate with the external world, nor with other brains, so far as we know, except through the medium of the body. Consider how brain-power is formed and grows in a child. Is not the first exertion of mental power, as well as the first sign of life, connected with motion? Back of the child's outstretched hand there is in the mind a desire for something and a will to obtain it. Each consciously directed muscular action has two effects, one on the muscle used, another on the directing brain. Can there be any doubt that this mutual action of brain and body contributes to the growth of each? Can there be any further doubt that, the more organs which the brain supervises, and the more muscles which it controls and directs, the more opportunity the brain has for growth? "Brain is evolved from the organization." † First, there is "growth, the force for which was supplied from a hundred sources"; and, secondly, there is "a power grown. . . . No perfect brain ever crowns an imperfectly developed body." This, then, up to a certain time of life, is Nature's method of forming brain-power, viz., by the conscious activity of the bodily powers. The fact that most people are right-sided as well as right-handed is registered in their brains; the *left* side of the brain, which supervises the *right* side of the body, being generally the larger.

In this growth of the brain, the whole nervous system is involved. The spinal cord (almost a continuation of the brain), and every nerve, which from each organ brings intelligence of want, and every nerve that flashes the order to supply that want, all are brought into action

* Bain. † "Building of a Brain," Dr. Edward H. Clarke.

by exercise, and all are nourished by the circulating blood. Think of the immense strain upon the bodily powers to keep the brain and nervous system properly nourished! It is calculated that the brain alone requires one fifth of the entire supply of blood in the body. The drain upon the bodily vigor of a brain-worker would be greater than this fraction represents, if it were not for the law of Treviranus, according to which an organ not only takes from the blood certain materials, but also supplies to it other materials. "Just as, on a larger scale, the carbonic acid exhaled by animals is taken up by vegetables, and a poison thus removed from the atmosphere in which the animal lives, so by one organic element of the body the blood is purified from the waste matter of a higher element, which would be poisonous to it."* So that a tired brain and quivering nerves may not be more wearied by physical exercise, but may be refreshed by it. This refreshment may result from two processes: first, by withdrawing the excessive supply of blood from the before active organ; and, secondly, by purifying the blood so that it may be ready to properly nourish the brain. And the muscular system not only acts as a store-house of vitality for the brain, and a purifier of its supply of blood, but it covers the nervous system, acting as its stay and protection. "To be weak is to be miserable. . . . Susceptibility of nerve and feebleness of muscle generally go together." To correct one deficiency is usually to cure the other weakness.

To the young, physical exercise is essential to growth, both of body and mind. Youth is not only the time to cultivate good habits, but also the time to store up vitality. At that time many abnormal developments can be corrected by appropriate exercises. At that period, too, the healthy balance between brain and body can better be established. To children, exercise is specially needful for healthy nerves, since, as compared with the nervous system of an adult, the nervous system of a child is five times as large, in proportion to the size of the body. In them, therefore, "that parasite of the blood," the brain, demands that a greater amount of time should be given to waste and repair of tissue by means of exercise, and that a greater amount of proper food should furnish the supply of nourishment. Short intervals of study, long intervals of play or light work of body, and that in the open air, if possible, should be the rule for children. As they increase in years more time can be given to conscious cerebration. At some periods of growth, all the way from the age of twelve to eighteen, according to the individual, special watchfulness is required of parents and instructors to see that the functions of growing organs are not interfered with by excessive attention to brain-work. At this critical time no study would be safer than too much study.

After a good muscular system has been developed in childhood and youth, a comparatively small amount of time judiciously devoted to

* Maudsley.

exercise will keep a person in healthy working order till near the age of forty.

The age of forty to fifty is the period of life during which, according to the best authorities, the need of exercise is the greatest. "At no time of life is the necessity of exercise so imperative.* . . . At that time the circulation becomes defective, unless continually quickened by exercise"; there is a tendency to passive congestion and functional derangements of various organs, especially the liver. At this time, though needing less food, we are apt to eat more than in the periods of life immediately adjacent. Consequently, the products of disintegrated food and tissue are not eliminated. Accumulating in the blood, they form the *materies morbi,* the matter on which death feeds.

Tiding over the period of middle life, by using appropriate exercise, and by care to see that all the excretory organs do their proper work at proper times, we ought to find the following years the best years of life, especially for brain-work. If we lived rightly, the words of the poet ought to be true for us all:

> "Grow old along with me!
> The best is yet to be,
> The last of life for which the first was made;
> Our times are in his hand
> Who saith, 'A whole I planned,'
> Youth shows but half: trust God; see all, nor be afraid." †

As to kinds of exercise, each person must be thrown on his own judgment with regard to his own case. In McLaren's "Physical Education," and in Blaikie's "How to Get Strong and How to Stay So," most excellent hints will be found for all cases. In beginning a course of systematic exercise, it is wise to err on the side of doing too little rather than too much. Increase the amount of exercise very slowly. No discouragement should be felt if it is hard work at first. It will become easier and easier. It may be a long time before it can be taken joyfully, yet, if any person will persevere, he will be certain to rejoice in the work, and will come to feel that he can not do without it. There is no royal road to health any more than there is to learning. Like all things made precious and to be really enjoyed, health must be earned.

It may be said that, for all persons whose regular occupation is sedentary, exercise in the open air is to be preferred. The oxygen of the air is essential to the life of the blood. It is well also to take exercise as much as possible in company. One person encourages another. A man will often take part in exercise with a companion so as not to disappoint him, even if he would not exercise for his own sake. Hence one valuable feature of games or athletic sports. They must be carried on in company and by system. Another valuable feature of games

* "Exercise and Training," Ralfe.

† "Rabbi Ben Ezra," Robert Browning.

and sports is that in them the mind is occupied without being taxed. It is diverted from its usual cares. The sports are well called recreative. Both body and mind are recreated by them.

To affect the chest and the underlying organs, such as lungs and heart, the most direct means lies in exercise of the muscles of the arms and shoulders. If a person has weak lungs, one of the first objects at which he should aim should be the strengthening the muscular system covering the chest. If such a person is weak, let him begin exercise very cautiously, and increase very slowly the duration, frequency, and difficulty of his exercises until he is made to breathe hard. In taking a full inspiration, not only are the lungs affected, but, strange as it may seem, the brain and spine also. "The fluid surrounding the brain and spinal cord is essential to their safety. The motions dependent on the action of the heart are much weaker on the spinal cord than on the brain, while those connected with breathing are more constant and considerable on the former, from the more powerful distention of the veins of the spinal canal. . . . The fluid surrounding brain and spine regulates their vascular fullness," and "it is manifest that, in order to keep up the proper alternations between the brain and spinal cord, and between the heart and lungs, it is not enough to breathe pure air, but it is also necessary that it should be *deeply* breathed." *

The effect of exercise on the character is felt most of all on the will. This is very natural, for in all muscular exercise a certain amount of resistance has to be overcome, and the power which acts through the muscles to overcome this resistance is will-power. Development of muscular strength is, therefore, to a certain extent development of will. It becomes development of the highest kind of will, that of self-mastery—when to take exercise a man resolutely overcomes the distaste for it. This feeling often comes upon us, when we are weary with brain-work and are inclined to rest, and to forego exercise. But let any man resist the temptation and take the exercise, and he will find that the brain is rested and refreshed, and the whole body renewed and invigorated.

It is not true that so much given to body is just so much taken from brain. It has been the aim of the writer to show that all parts of the body, the brain and the nervous system among the rest, contribute to the vigor of the whole; that the muscular system forms about half of the body, and is a very important contributor to the health of all the organs. Body and brain are parts of a harmonious whole. Either neglected makes trouble for the other. Each appropriately exercised means not only health and strength to that one, but vigor to both. This hue and cry against exercise and sport, as being detrimental to mental culture, is founded on a mistaken theory that the material and spiritual parts of a man are enemies—so much less material, so much more spiritual. But it ought to be observed that a

* Dr. George Moore.

very high authority says it is the "carnal *mind* which is enmity against God," and "out of the *heart* proceed evil thoughts, murders, adulteries." Man is not more of a "brute" for cultivating his body, but a better man if he cultivate both body and mind: body, first in the order of development; mind, second in order of time, but the crown and king of the whole.

TRANSPORTATION AND THE FEDERAL GOVERNMENT.

By JOHN C. WELCH.

MOST of the great fortunes of the United States—those that are unduly great—are ascribed to the rapid development of the means of transportation and the facility with which those means have been centered in comparatively few hands. The general sense of the nation is that this concentration of power, of wealth, is an evil, and that it would be much better if we could have had the development of the transportation interests that we have had with a greater diffusion of the power and wealth that have attended them. The founders of our republic thought they were establishing civil institutions where enormous fortunes would be comparatively unknown. A hundred years have hardly passed—certainly not a long time in national life—when the largest individual fortune of the world is accredited to the United States, and there are others that approximate this in magnitude, and many of them dating back to less than one fifth of a century. In the matter of private wealth, we have clearly departed from the ideas of our fathers. In this departure is there adherence to the stern principles of republicanism with which our country started out, and have these growths been fortuitous, exceptional, easily swallowed up in the general growth and prosperity of the country, so that the spirit of our institutions is unchanged, and are these fortunes to be dissipated in an early succeeding generation, and not to be replaced by others of equal or greater magnitude and greater in number? The instincts of the nation are that danger lurks in any other solution of these inquiries than in the line of suppression of causes that have made these fortunes possible. Nor can the subject be dismissed on the ground that, in the development of the use of the physical forces of steam and electricity that this generation has seen, there is inherent this aggregation of wealth in few hands. The disproof of this is that in European countries that have enjoyed a like favorable development with ourselves in wealth, barring that which came from our virgin territory, such developments of the physical forces in their administration and the accompanying emoluments have not been centralized upon a few.

These administrative emoluments, in the case of railroads, accruing to so few, may be briefly summarized as follows:

1. The gratuitous distribution of stock to promoters and the construction of the railroad from the sale of mortgage bonds, and by defaulted bills for merchandise and labor.

2. Construction boards, corporations, committees, directors, made up of promoters who handle the cash realized from the sale of bonds and the credit which has been established for the property, and who are practically irresponsible, as they report from themselves as constructors to themselves as proprietary directors.

3. Express and other companies making use of the franchises of the original company and its road-bed, and taking to themselves the cream of the business.

4. Rebates, drawbacks, and the various devices by which favored shippers are allowed to usurp the business of the road, or the bulk of it, in certain channels, and in which the profit accruing to them from paying less freight is directly but the minimum advantage to them, as by it they may control the production, manufacture, and marketing, and real and speculative prices of an important commodity, and so, by eliminating competition and controlling speculation, draw enormous profits from the public that do not show at all in the simple handling of the articles as freight.

5. The property being corporate, and its ownership represented by negotiable stocks and bonds, and which have gone largely into the hands of the public, both by the natural and manipulated fluctuations which take place in the negotiable securities, those that are "outside" are at immense disadvantage compared to those that are "inside," and a perennial source of profit is at hand for the "few" who have reached the advantageous positions. By possessing inside knowledge of a number of leading companies, by making money in the loan market scarce or plentiful, the whole stock market can be "raided" for the benefit of one or more operators.

6. The wrecking, intentional or otherwise, of valuable property through accumulated mortgages and debts, and its re-establishment at a comparatively small cost to the new owners.

7. The consolidation of different companies: those that are continuous on the same lines; those that are parallel, and originally designed to be competitive, and those that radiate from a common center or do the business of a particular section. To make one company of two or more companies, to economize in administration, to make them probably more effective, to eliminate competition, has been generally unlooked for, and has added greatly to the economic position, and consequently to the value of the railroads as paying properties. While the consolidation may be meritorious, this has afforded the chief opportunity for "stock-watering," and is a field where Napoleons of finance have specially distinguished themselves and enhanced their wealth.

8. The large salaries paid high railroad officials is to a great degree only a legalized method of giving them an important part of the emoluments received. Their positions being free from the strain of personal competition and risk of capital, such as attend the business man, and without the pressure of social expenses and duties, such as rest upon the high government official, and frequently destitute of requirements of expert skill and professional knowledge, such as often command prizes of the highest kind, they are altogether without a parallel as remunerated positions.

Electric, gas, and other companies represent branches of transportation, of which railroads are the great representatives, and much is true of these companies that is true of railroad companies, and all stand on much the same ground regarding salaries paid to their high officials and in their general effects.

In contrast to these advantages accruing to railroad organizers and managers, the advantages that are supposed to accrue by the organization of railroad and all other stock companies, and to which prospectuses however flattering, are confined, are—

1. The profit on the investment through rise in the value of the property, and dividends to those who give valuable considerations for stocks and bonds.

2. The indirect benefit that will accrue to other properties, and the public convenience and advantage that will be derived from the operations of the company.

Where legitimacy begins and where it ends in such organization and management is a question of casuistry in particular cases, but there has been swerving enough from what is legitimate to make it the startling and pronounced feature of American commercial life for the past twenty-five years.

As the result of such illegitimacy, as the leading cause, what do we find?

We find Pelion piled on Ossa in the matter of private wealth.

We find the ideas of equality and simplicity on which the Government was founded stultified in the house of their friends.

We find fiery zeal and many successes in making millions and multiples of millions, and the hardships of acquiring a competence, increasing.

We find a class that exceed any class of officers in the Government in the importance of tenure and their power—*imperium in imperio.*

We find the individual less assertive than a generation ago of his independence, and the typical, prosperous citizen eats the bread of dependence upon a corporation, or controls one or more.

We find an important number of the influential members of the class that is and has been most influential in this country since the organization of the Government, lawyers—the only learned class active in affairs, officers of courts, the chief legislators and law-makers of the

States and nation, the class alone from which the judiciary is chosen—"retained," made comfortable in their income year in and year out, without respect to the duties they perform or the offices they hold, barring judicial positions, by the powerful transportation companies.

We find citizens, officers, law-makers and judges overawed and corrupted by a power that yields no adequate subjection to the powers of the State.

We find a public sentiment alarmed at this situation, but almost despairing how to act helpfully.

We find threats to deal with the matter summarily, and with precedents that it is the unexpected that happens, with knowledge of the destroying power in human society of the ebullition of collected human passion, it is not the part of wisdom not to inquire into and to be indifferent to these threats; and such an inquiry is specially obligatory in a popular government like that of the United States.

The *status* of transportation—whether it is an affair of commerce or the body politic, or part of one and part of the other, and the ill defined thought and the unpronounced action upon it—marks the first point of the difficulty.

Second, we have had a strong leaning to it as purely a matter of commerce.

Third, in the presence of a sentiment that has at length reached public conviction that it is partly at least an affair of the body politic, has arisen an embarrassment of how to treat it as such.

The embarrassment is greatly augmented in the fact that we are under a dual government of local and general authority, between which the lines are not clearly drawn, and which has been a burning question of politics, and many believe may be again fanned into a flame.

The civil war was latterly an affair of sections of the country, but the sentiment that led to it rested largely upon the question of local or general, State or national Government, and many have hoped that no serious point would ever arise again in this controversy. While the railroad problem is not a matter wherein jealousy has been engendered between the States and the General Government, it has been viewed in the light of a matter between local and centralized authority and so subject in some degree to the feeling or prejudice accentuated by the war, that was anterior to it and that largely had its growth as a national issue in the desire of the South to protect the institution of slavery. The result of that war was on the side of the General Government as an issue of local and General Government, as well as in the main issue, but on all sides the distaste is pronounced for more issues partaking of this character.

From the view that transportation, on the colossal scale on which we have railroad transportation in this country, is in some measure a matter of government, it is plain now, and seems as though it might

have been plain at any time, that it is too wide in its scope to be treated successfully by the local State governments. There are two divisions to the subject from the national standpoint:

The position of the Government toward it as defined by the Constitution.

The general ground on which governmental action stands, making it necessary. Of what that action should be, this paper does not aim to treat.

1. The language of the Constitution pertaining to the subject is, "Congress shall have power to regulate commerce with foreign nations, and among the several States, and with the Indian tribes."

Applying this to railroads, the interpretation commonly made is that where a railroad company's chief means of transportation, that is its tracks, extend from one State into another, such railroad company comes constitutionally under the regulation of Congress. The framers of the Constitution certainly had no intention pertaining to transportation in its present form that helps us to interpret this clause of the instrument which they drew; their intention only pertained to the wider generalization—commerce, and must have been suggested by arrangements ordinarily entered into by adjoining States that had no Federal bond. Such arrangements were chiefly treaties. Hence the Constitution debars commercial treaties between States.

"Commerce among the States" is immensely wider in its scope than the mere transference of commodities or passengers over the line of adjoining States. Any railroad or other transportation company that enters into an arrangement with another transportation company for the movement of commodities or passengers from one part of the country to another (and this can not be done except by traversing different States) is a participant in commerce among the States, and so amenable to the clause of the Constitution covering such an act. To claim that a transportation company must actually perform the act of transference from one State into another is standing on the narrowest technical ground, and stands in a very subordinate and unimportant relation to the vital functions of commerce, and would be a poor thing to rest an important relation upon. The company that receipts for property, or sells tickets to passengers, to go out of the State in which these acts are performed, or which delivers property and accepts pay for the transportation of such, which came from other transportation companies and from other States, and which honors tickets for passengers sold by other companies in other States, certainly participates in commerce among the States whether its own property and track is wholly located in one State or not.

2. The special surprise that has taken place in regard to railroad transportation, outside of its mechanical effects (and this is true of other forms of transportation), is the tendency to centralization of management of interests that at the outset appeared to have no special

connection or that were distinctly hostile. Railroads sprang up at first in subservience of local interests, and have been welded and are being welded together in subservience of general interests. The logic of economy and public advantage has overridden the individualities of men, the strifes of communities, the ignorances and prejudices of the public mind. Railroad management becomes less and less local, and more and more an affair dictated by events and beyond the grasp of any one mind or any number of minds that can act in unison. The great names in railroad affairs are not great by reason of overpowering genius, but by reason of the consolidations forced by events, the elimination of the men representing the smaller interests, and by the concentration of power in the hands of him who by his superiority over his associates or competitors, or by something fortuitous, becomes the representative of the combined interests.

The public mind does not grudge extraordinary rewards and power to genius and great public service, but it is galled to see such thrown by circumstances into the hands of men only actuated by personal aims. When such a condition of things grows into a national system; when in substance empires in domain have been parceled out to a few individuals, when we suspect that a few individuals are absorbing the growing wealth of the country, and perhaps more—the past acquisitions; when a plutocracy threatens to become greater than political parties, to wield more power and become superior to the chosen representatives of the people, it is high time to sift the character of their tenure, to inquire whether we have become a nation of *Bombastes Furiosos* in civil affairs; whether the Fourth-of-July oratory of past generations was a mere exercitation of the cerebrum and diaphragm of budding orators or traditionary wind-bags; whether if Providence has favored infants, drunkards, and the United States, as has been intimated by our European fellow-men, has it not withdrawn, or is it not rapidly withdrawing, its favors from the United States? While European nations have been growing toward a greater diffusion of civil rights, in the United States the sovereignty of the individual man has declined, and wealth and a class that wealth creates have become known at the polls and in the Legislatures; and the courts themselves, the very flower of the virtue and intelligence of the people, are strongly charged in some cases with contamination.

Consolidation, consolidation, consolidation, is the trend in the development of transportation. This is so, in spite of the competitive principle on which our nation has sought to stand. This nation has sought to look to no rulers of great and long-continued importance. It has stood on the ground of reinstating its rulers with power at short intervals; this emphasizes the idea that the sovereign power rests with the people. Next to this, the dominating idea on which we have rested has been that competition among our citizens would control our affairs. The theory of no-government—in that part of it which does

not delegate large power to individuals—and the let-alone theory have gone hand in hand in our public policy. But, curiously or otherwise, the compact of thought of the fathers with its traditional acceptance by intervening generations does not hold pure in deed at this time. There was aggressive statesmanship in founding the republic; the statesmanship since that day has not been aggressive. The most distinguished names in civil affairs since that day have been Jackson and Lincoln, whose aggressiveness has been that of repelling innovations or evils; Lincoln broke the back of the slave-power and of the rebellion by his Emancipation Proclamation, and attained the highest point of inspiration and daring ever yet reached by an American statesman; but it was the heroic stroke of defense, not of aggression. No statesmanship arose, during the forty years that it was practically an issue, that was able and aggressive enough to keep back the war for slavery and secession, although it was proved immediately after the war was over that it was a war for an abstraction—an abstraction of selfishness, ignorance, and prejudice that was dissipated in the light of a new day, and an abstraction that might have been dissipated a generation earlier, without the bellows of war, with a different order of statesmanship.

While we may be proud of our founders, we need not be proud of all the statesmanship that has preceded us, nor accept the belief that a final orthodoxy has been reached in this country for the government of a great nation.

It is certainly not the highest order of society that it should be automatic; it is so in China. Accepting this to be the fact, we need not fight off innovations as though in them were the seeds of destruction.

What is it that now confronts us in the *status* of the transportation companies, the monopolies *par excellence* of this country?

The chief proprietors have life-leases of power, to be bequeathed to whom they will, while civil officers and legislators have to go frequently back to the people to be reinstated or deposed.

They have wealth beyond the dreams of avarice.

They build up a subsidiary class around them, who establish colossal fortunes by special rates, rebates, and drawbacks, and are exempt from the American principle of competition. Of this class the Standard Oil Company is the great type.

They possess great power over the incomes and savings of the people by controlling avenues of investment, and can and do greatly use this power to absorb such investments for themselves.

They have the power to tax commerce arbitrarily, and so tax it all they think it will bear, barred only by one strong influence, their internal jealousies.

They check personal ambition, independence, and enterprise, as success in very important fields of activity can only be obtained through them.

The rapidity and ease with which their fortunes have been acquired, the magnitude of their fortunes, their freedom from personal relations, and consequent freedom from sense of obligation to those from whom they derive their incomes, make them a class favored above any other that has ever existed.

And yet the spirit of much of our society is that there is no opposing power to draw upon; it is a case of *laissez faire;* the evil, if it be an evil, and in so far as it is an evil, will work itself out in time.

A representative of the class has drawn a parallel between himself and his class and the highest representatives of the political power of the people. The New York "Sun," of December 14, 1885, gives an account of an interview, between its reporter and Mr. Chauncey M. Depew, concerning the late Mr. Vanderbilt. "The Sun's" interviews, as is well known, are approved before publication by the person interviewed. Said Mr. Depew: "He had a poor opinion of politicians of all kinds. He said to me: 'What is there in politics to be desired? There is no money in it, and by going into it a man breaks up his business and is generally unable to resume it afterward. It lays him open to endless abuse and gives him no end of trouble. There is very little honor in it. Politicians never impressed me at all. I had three United States Senators in my office the other day, and I paid no more attention to them than if they were so many clerks. If they had been great shippers, great railroad men, or great business men of any kind, I should have been interested in them, but as it was I did not understand them. They do not impress me at all. Whenever I go to Washington they want to sell me a patent, or ask for a place on some of my roads, saying that they want to get out of politics.'"

Does not this reflect correctly the opinion of railroad magnates themselves, and in great degree popular opinion, that these magnates are greater than the highest representatives of the people—that there is no law to which, from the pinnacles of their greatness, they are amenable?

I have claimed consolidation as the special and remarkable feature of transportation, whether it be of railroads in any of their forms, telegraph-lines, gas-lines, and still other forms of transportation developed and developing. These consolidations are national and municipal in their character, tending to the bringing any one system, however extensive it may be, under a single management. Instances are almost too trite to be worthy of mention. In the greatest examples, we have the Western Union Telegraph Company; the Huntington, the Garrett, the Gould, the Vanderbilt, and other railroad systems; in municipal affairs, the consolidation of the elevated railroads of New York; in less degree, the consolidation of the ordinary street-lines, and the consolidation of the gas interests. How far do we have to look into futurity to see, judging by the past, the management of the railroads of the United States emanating from a single office?

In this service of transportation the individuals who are served cohere, they become the public; the transportation company, acting in its proper sphere, is the "servant" of the public as the President and all executive officers are servants of the public and of the people. If transportation companies favor one it does not end there, it injures somebody else; the favor received is an injury to the business competitor of the favored one. This is positive evidence, as the condemnations of public and private property for their use is negative evidence, that they exercise public functions.

If it was not profitable for individuals to establish the most approved means of transportation, it would be the duty of the State to establish them. On this theory the United States Government grants lands and its credit for the construction of the Pacific Railroads, individual States have built canals, and cities construct water-works and sewers.

All this, in connection with the character of the power of railroad and other transportation managers, means that they riot in the exercise of public power, and in the execution of public functions, the same as kings rioted in their power before it was satisfactorily demonstrated that their only or most legitimate use was to exercise for the interest of the public a delegated power.

The United States, standing on the ground of *laissez faire* more than any other civilized nation, has been the slowest in asserting itself in regard to the public functions of railroad companies, and, while we can not weigh accurately the value to us as a nation of over-construction and over-competition in railroads, presuming that there has been a value in them, we have had violence done to the spirit of our institutions; we have had the conditions of life, actual or relative, made harder to the average man; we have had suspicions cast upon the *dictum* of Lincoln, that this is a government of the people, by the people, and for the people; and we have seen the transportation corporations usurp or control the wealth, the honors, the Government (of their own specific and of a general kind) of the United States in a way that is abhorrent to the general sense of justice of civilized, or at least English-speaking, people. We have arrived at that position where we can not claim much advantage except our virgin soil, and what comes from our extent and isolation, over the governments of Europe that emerged into civilization from the dark ages, whose people have been afflicted with the theory of the divine right of kings, and who are, in one country or another, now loaded with primogeniture, entail, aristocratic orders in society, church government imposed upon state government, and a system so prejudicial to personal advantage that years of youth are condemned to participation in, or preparation for, war. The special kind of humanity that, it has been claimed, grew and would continue to grow on American soil, seems to have many departures from the boasted type, and we assimilate more and more to the older govern-

ments, or—if we go on as we are going shall we not be forced to admit it?—to the more steadfast types of civilization.

Already the Toryism of Great Britain is looking with admiring gaze to the Democracy of the United States, rapidly establishing, as it is, a privileged and a favored class, and such leaders as Chamberlain and Morley, on the crest of a forward movement, men of office and a great following, forge ahead on the line of equality and freedom such as the latter part of the nineteenth century has brought forward, and give small heed to the teachings and institutions of the United States.

Back of all these facts and postulates is the question, How far is transportation legitimately a subject of government, a branch of government—this as distinguished from being a matter merely of commercial enterprise? We see how easily transportation runs to one head, to one leadership. Competition does not keep this back; we have thoroughly tried the competitive principle, with all the predilections of our people and our Government in its favor, and it has failed; competition has been eliminated; *nolens volens*, the single leadership is arriving or has arrived. The question, then, is, Is that leadership to be held by a single individual intent on seeking his own fortunes, building up bulwarks of private fortunes around him; breaking down resentment to his *bizarre* position by travesties of courts, by legislators who smile and smile, and see their way to vote for him, by *douceurs* to the placable, by dollars at elections, by free rides, by telegraph-franks, by proprietary and subsidized newspapers, by retainers to high-roller lawyers, by political economy manufactured expressly for his benefit, by pillars of society droning of the dangerous tendency of the times, by *laissez faire,* by audacious self-assertion and robbery, by chameleon politics, by lofty public spirit, by smiles, lies, and entreaties, by the advertising generous hand, by the adulations of intelligence and virtue which millions of dollars so easily command, and—when all else fail—by sordid and brute force pressed home on the weak or galled spot of the body politic or the private interest? This is the commercial side of transportation as presented in the United States in the year of grace 1886. Would it not be well to see what there is in governmental transportation, to pay some attention to the experience of contemned monarchical governments, to cry a halt on the liberty that permits one or a few to absorb the substance of the state; to organize this, or commence it at least, by some of the simple forms of regulation that demand publicity, that ferret out discriminations that mean commercial theft and punish them, that stop vibrations between low and high rates in accordance with the whims of disturbed gall or exultant avarice of transportation rulers, that stop the prior knowledge of a favored few of what is to be, and so deprive them of enormous advantages in trade and transportation?

This is the way, or the most important step, in the limitation of

wealth in the United States. Place no embargo on enterprise by a dead-line on which is written, "Thus far shalt thou go and no farther." Let the incentive of ambition, of avarice, if you will, be keen to the last, but hedge the opportunities so that no one man's opportunity greatly exceeds that of others ; put the strain, not on getting a living, a competence, but on getting enormous multiples of these. Even then extraordinary fortunes may come, but they will come as the result of circumstances that could not be guarded against, and as the result of commanding and extraordinary talent that never comes in rafts (which would be implied if the present great fortunes were taken as a criterion of ability), and these sporadic fortunes will not be a threat to and a corrupter of society ; they will not build up a separate class ; they will be seen as only one of the unusual things in social development.

A government relation to and regulation of railroads is classed with a larger general regulation of society by Government than we have heretofore had, and which is in course of development in Germany under the leadership of Bismarck ; which is constantly attaining greater ground in England in the popular mind under the leadership of Chamberlain and others, which is not strenuously objected to by Gladstone, and which bids fair, when that at present disturbed country gets rest from the exciting Irish question and has time to recover itself from the excitement of its recent foreign complications, to express itself in laws bearing on the internal polity of the country. The United States has not greatly entered the lists in this respect. It has not enlarged upon the principles of government incorporated by it in the Constitution ; it has been almost the last to yield the principle of slavery, and now stands by, seeing Germany, at least, trying experiments in government which it has not ventured upon. It must be ranked at present among the conservative governments of the world. The national trepidation of "reforms" is greatest in Great Britain, where there is not the absolutism to hold them in check that there is in Germany.

Suppose we want to stand on the ground of incorporating no new principle in our Government, where does that leave the railroad problem? We see the consolidations that have taken and are taking place. Those consolidations mean centralization, and centralization has been the *bête noir* of the United States. The question is, Shall that centralization remain in private hands, with the various ills and violence to our institutions that we are positive of, or shall it come under subjection to, or be shared by, the agents and representatives of the people ?

Certain things are natural in their regulation and government. The first of them is the war-power, which is the starting-point of civilization. Next is the preservation of order from disturbance by internal outbreaks and violence, which is the function of the police.

There is the preservation of custom and the growth of equity, which is the function of the law, the courts, the Legislature; and there is the execution of the law, which is the function of the ruler and his assistants. A superior civilization aids commerce by the establishment of lighthouses, by improvements of rivers and harbors, constructs canals, looks after the public health in the establishment of quarantine, prevents the spread of infectious disease, provides cities with water and sewers, seeks to insure education among its citizens, regulates and controls the medium of exchange. The governments of civilization have been progressive in these regards. This country now confronts the problem of too great power in the hands of the wielders of transportation—they thwart the first principles of our Government, and the iron of their oppression has entered into the soul of our people.

BOHEMIAN GLASS.

By Professor HEINRICH SCHWARZ.

THE northern edge of Bohemia, which borders on Silesia, Saxony, and Bavaria, is at once the principal seat of the German population of the country and of its industrial activity. A person approaching this border region from the interior will be struck at once with the contrast between the stagnation of the Czech districts and the freedom and active enterprise of the Germans, under the impulse of which a not very fertile soil has been made to support a dense population. Besides the textile industries which profitably utilize the water-powers of the mountainous region, and the large mining, metallurgical, and chemical enterprises, the ceramic establishments, and the manufactories of stone-ware, porcelain, and glass, are prominent features of the district.

Notwithstanding numerous efforts, the quality of the famous Bohemian art-glass has never been quite equaled anywhere else. The principal seat of its production is in Northeastern Bohemia, where this district is separated by the Riesengebirge from Silesia; but, as the result of the active trade which has been carried on over that chain for several centuries, branches of the manufacture have also spread into the latter country. The exquisite products of the *Josephinenhütte* at Warmbrunn have long maintained a rivalry with the Bohemian wares, and Frau Heckert's establishment in Petersdorff can exhibit wonderful specimens of luster and color, polish and etching, that might almost make one imagine he had been transported into Aladdin's palace. The bases of the manufacture are really the same on either side of the range. The mountains furnish a pure quartz and a limestone of snowy whiteness for raw materials, and the abundant woods, with which they were clothed, formerly supplied the best of fuel to the furnaces, while

the resultant ashes afforded the necessary potash. The Bohemian crystal serves in art as the type of the most perfect glass, and is unquestionably recognized as one of the superior kinds, rivaling in transparency and clear whiteness rock-crystal itself. Pure specimens of it, free from blisters, grains, and specks, have a peculiarly attractive look, even in their simplest forms. It is, moreover, by reason of its tenacity, its constancy of luster, hardness, and difficult fusibility, eminently adapted to artistic molding and ornamentation.

The heating of the furnace with wood only, from which a comparatively small quantity of ashes was produced, and they entering into the composition of the glass, contributed no little to the attainment of the highest perfection. While the glass-houses were at first built where they might be made a means of utilizing the superfluous wood, they have now to contend against a continually rising price of wood and increasing difficulty in procuring it. Some factories, like the Josephinenhütte of Count Schaffgotsch, and that of Count Harrach at Neuwelt, have the extensive forests of their owners to rely upon, while the much more important establishment of Joseph Riedel in Polaun is looking forward to direct railroad connection with the lower Silesian coal-mines or the Bohemian brown coal.

While formerly only the best, finely-split, well-seasoned trunk-wood could be depended upon to heat the furnaces to the needed temperature, the required degree is now obtained from limbs, knots, roots, and even green wood, by distilling the gas from them in an imperfectly ventilated regenerator, and burning it with the aid of previously heated air. By this means is obtained a clear, excessively hot flame, by which the most infusible glass is made as fluid as water, and of a very high state of purity. Many experiments will be necessary before such excellence can be obtained with coal-gas; and, in any event, a previous washing of the gas will be required to clear it from tar and ashes. The form of the furnace, the manner of introducing, purifying, and tempering the glass, the processes of bringing it into shape, and the shaping tools, do not vary essentially from those of the old ways; except that complicated figures engraved in iron and brass molds are now applied, the complete transference of which to the glass necessitates the use of air under high pressure. This is furnished by means of a hand compression-pump, so arranged in connection with the other parts of the apparatus that the manipulator can bring it to bear upon the melted glass at the precise moment when it must be brought into the closest contact with the engraved pattern. Other pieces, of a massive character, such as lenses and ring-segments for lighthouse-lanterns, which are now made on a large scale at Polaun, are formed by subjecting the material to a light pressure between an upper and a lower mold. They are then finished and polished after they have cooled.

The after-decoration of the glass is various, and subject to the fre-

quent changes of fashion. New patterns bring a high price and find a ready sale till they are crowded out of the market by newer ones. For a long time the old German fashion ruled in glass, and manufacturers were obliged to use crude, impure colors, as if they were working in the childhood of art. Now, when we remember that glass-work has been regarded from a time long past as properly an effort to obtain the clearness of rock-crystal and other precious stones, it should appear that it was wrong deliberately to come down from that high ideal. The question is the one involved in the old contest of the artists with the artisans, which is still carried on with reference to the modern coal-tar colors. The former dislike these colors because they are too pronounced; the latter are inclined to regard them with more and more favor, on account of their brilliant luster, purity, and strength of color.

The author's studies of the Venetian mosaic glasses satisfied him that the harmony of the designs composed out of them was due to the subdued, broken coloring of the pieces that entered into the work, and that this was due again to the application of an impure, ferruginous sand in the melting. We must not, however, forget that glass is used in our houses, along with the precious metals, to bring out the highest lights, which even the most harmonious pictures can not dispense with. The purer, the more lustrous, and more brilliant the color of the glass, the better it answers this purpose.

The ornamentation of the glass is done partly in connection with the exposure in the furnace, and partly in the finishing-shops, where the work is completed by cutting, polishing, tarnishing, etching, painting, and mounting in metal. The glass-houses have at their command a very complete color-scale for transparent, opaque, and clouded glasses. But it must not be supposed that a crucible is placed in the furnace for each color, from which glass colored for each ornament is to be made. The colors are worked out by means of what are called pastes, which are kept on hand in sticks or cakes. From pieces of these pastes previously warmed till they are soft, suitable quantities are cut off, laid upon the foundation of white or colored glass, and then spread out by drawing or blowing. By this means only is an economical use of such costly materials as gold and silver compositions possible. Some of the glasses thus treated—gold, copper, and silver glasses—remain still little, or not at all, colored after the melting, shaping, and quick cooling; and do not take on their bright hues till they are reheated. This is the case with the new yellow-silver glass, which continues uncolored after the intermelting of the silver salt until it is exposed in the furnace again. Very fine effects are produced by blending or overrunning of the paste-colors provided proper attention is given to the laws of harmony. A blue-glass cup is, for example, overlaid with silver glass at its upper edge, and this is drawn down in gradually thinner tones till it fades away at the foot of the vase. Gold and copper ruby-colors are thus combined with green

glasses, etc. Another brilliant effect is produced when a still hot bulb of glass is rolled in finely pulverized aventurine glass,* and after this is melted, and previous to the shaping of the vessel, is overlaid with a coating of either colored or colorless glass. A still finer effect is obtained with mica-brocade. The mineral mica, which has deceived so many persons by its golden or silvery glitter, besides being applied as a substitute for metallic bronze dusts, can be colored by the aniline dyes in all manner of colors and shapes. The coarse powder called brocade is used in glass-work, and the color-effect is produced by overlaying it with colored glass. A bulb is blown, for example, out of clear blue glass, is rolled in the brocade, which readily adheres to it, and is then overlaid with yellow glass. The brocade will appear, when looked at from within, of a steel color ; from without, of the color of gold. Every flake will reflect the light, colored according as it is looked at.

A recent kind of decoration is shown in those glasses which appear to be held together by a network of gold-thread. This is made by preparing a skeleton of brass wire, and then introducing the glass and blowing it till its mass, having penetrated the interstices of the network, spreads over it and tightly incloses it. The full effect is then brought out by a subsequent etching away of the metal, and galvanic gilding or silvering. Other metal ornaments, insertions, buttons, drops, or *figurini*, are often combined with this. They are cast in steel-engraved forms of type-metal, which reproduce the finest details, and are then galvanically coppered, silvered, or gilded. Another pretty effect is obtained from the clouding which glasses mixed with bone-ashes exhibit on being heated. If a bulb of this kind of glass is blown into a metallic form which is dotted with projecting points, a quick cooling ensues at these places, which leaves its mark after the reheating and finishing in the shape of a regularly distributed clouding.

Only a little need be said, and that of the most modern operations, of finishing, of the grinding, tarnishing, and polishing, ornamentation with gold-leaf and platinum-foil, luster, and enamel coloring, etc. One of the most noteworthy of these operations is that of tarnishing by the centrifugal sand-blast. The objects to be treated by this process are fastened upon revolving wooden pegs in the walls of a wooden box ; the sand is introduced into the middle of the box, and is thrown by rapidly rotating fans against its sides and against the glass figures. After it has done its work upon the figures it falls upon the funnel-shaped floor, to flow away and be lifted up again.

A charming effect is produced at the Neuwelt houses by means of a guillocheeing machine in which an engraver's tool is drawn in regularly massed lines over the slowly revolving vase. The vessel has been

* A glass containing bright metallic flakes, probably copper crystals in a brown magma. It is made with rare perfection, by a secret process, in Venice.

previously covered with etcher's varnish, which is removed from the lines of the engraving, where the bare glass is afterward exposed to hydrofluoric acid. In this way are produced the wave designs resembling those which are seen on the more finely engraved bank-notes.

In another very recent style of ornamentation, fine Venetian glass-pearls of various colors are glued by a very fusible enamel upon the surface of the finished vessel. As the arrangement is made in the cold, the work admits of a complete artistic freedom. The enamel is then dried and the setting is fixed by heating.

Another important function of the melting-furnaces is to furnish raw material for the now considerable small-glass industries in the shape of sticks and fragments of colored glass. The favorite color for these is a dark violet or black; but colorless glass is used for the pendants of chandeliers, and they are sometimes given a reddish tint by overlaying them thinly with gold-ruby. Sticks partly overlaid with opaque glass are used in a similar manner. There are always accumulating, in the glass-houses and other shops, piles of droppings, overflows, and pieces of many colors, which can be sold for very cheap prices. All this stuff is pounded up and mixed together with the addition of manganese or other coloring oxides, and is remelted in a special furnace. The workmen take out suitable quantities of this mass, and, by a series of deft manipulations, form it into sticks about as thick as one's thumb.

Very thin globes of about the size and shape of a vitriol-flask are made from the same dark glass, to be again broken up into sherds, which can be packed away in boxes. The manufacturer cuts from these sherds slightly curved plates, such as are used, for example, as foundations for brocades.

The shops of the small-workers are of the simplest character. Wherever one of the numerous little streams makes it possible to get water-power enough to drive a grinding and polishing wheel, and in the modest houses scattered along the mountain-slopes, may be found the establishments of these industrials, in which the working force of the whole family finds active employment. The artisan buys his sticks and sherds from the glass-house. A little wood-furnace, somewhat like a tinker's furnace, gives facilities for heating four or five of the glass sticks at once, which are taken out and used alternately as the ends are softened in the fire. The softened end is fastened upon by a pair of pincers, drawn out a little, and introduced into a mold in which is carved the figure of the object into which it is designed to be formed, and which is firmly stamped upon it by closing the mold and the application of pressure. If the mold is too cold, the form will be imperfectly made and the glass will be brittle; if it is too hot, the glass is liable to stick in it. Fortunately, it can be easily worked to a suitable temperature. The molded pieces are thrown into an earthen

pot, which is kept warm by a moderate flame and serves the purpose of a cooling-vessel.

The button, or whatever is the article manufactured, is still only in the rude state, with the edges yet rough and the surfaces uneven, but already provided with holes for the after-insertion of metallic eyes. The rough edges are smoothed away by grinding on the grooved periphery of a wet sandstone, being held to it by a wooden clamp which is managed by the right hand while it is turned with the left. The surfaces are ground with wet sand on horizontal, fast-turning iron plates, and afterward polished on the face of soft wooden wheels roughened with Tripoli dust. To speed the operation, the workman presses upon the piece with both hands and gives it a peculiar rotary motion that equalizes the stronger friction to which the parts nearest in contact are exposed. The proper application of this movement is a matter of knack, and is founded on mathematical principles, which also appear when the object is rubbed on a solid base, in the epicycloid lines which it is made to describe. On account of the relatively long time required for the operation of polishing, the smaller articles are subjected to what is called a fire-polishing, in which the smoothly ground pieces, imbedded on a plate of clay in fine sand, are heated in a muffle till their surface runs. If more strongly curved plates are wanted, to form a rose, for instance, the disks, previously prepared by notching and perforation in the middle, are placed in funnel-shaped crucibles in the hot muffle. The central part of the disk sinks on being heated. The hollowed leaves are then set one in another, in the order of their diminishing size, and fastened together by a glass-headed pin.

The foundation of the design is formed of a brass plate which has been previously shaped and perforated. Additional decorations are given by means of little beads, which are melted off in the glass-blower's lamp from thin threads of glass, and find their places in minute holes in the plate. Black sealing-wax is added to heighten the gloss and the blackness, as well as to cement the parts together. In other cases lighter figures are made by partly polishing or by etching them out on the smooth background. Iridization of beads, buttons, etc., has been much in vogue for a few years past; by this process those articles are given a metallic appearance. The luster of gold or silver is imparted by covering the black glass with a silver- or gold-leaf varnish and afterward heating moderately in a muffle. Peculiar tarnish-effects are given by the application of what are called luster-colors; and, lastly, these are shaded by a brief treatment with chloride-of-tin vapor. The glass articles, hung upon a wire, having been previously warmed in the muffle-furnace, are drawn through the thick white vapors which are formed when a spoonful of the tin-salt is dropped upon red-hot iron. A long experience and considerable manual dexterity are required to make sure of getting the particular iris-color

that is wanted, which is dependent upon a very well-defined minimum thickness of the coating. In this is involved a question of interference-colors, the same as is involved in soap-bubbles and the temper-colors of steel, in which there must be an exact difference in the wave-lengths of the light reflected from the upper and lower surfaces of the coating. Many colors, like steel-green, require repeated trials to be brought out in their full beauty. The advance that has been made in this art has been illustrated to me in a specimen-sheet of beads which are designed to make trimmings exactly corresponding in color for silks of a very great variety of shades.

In addition to the glass industry, a very extensive interest has been developed in the manufacture of brass, bronze, pinchbeck, etc., in which use is made of various galvanic coatings of metal. These branches of the art are carefully taught in the industrial school at Gablonz.—*Translated for the Popular Science Monthly from Unsere Zeit.*

GEOLOGICAL CLIMATE IN HIGH LATITUDES.*

By C. B. WARRING, Ph. D.

THE peculiar climate of geological times has hitherto been treated as if it were a question of temperature only. Scientists have sought the cause of the remarkable warmth in arctic regions, but have left untouched other questions of equal and perhaps greater importance.

One can hardly contemplate the climatic conditions of that remote period without inquiring how there could be other than a great difference of temperature between the summers and winters of lands less than 8° from the pole ; and how could circumstances—environments—so unlike as the four or five months of day of those regions, and the twelve-hour day of the tropics, fail to induce great specific differences in their fauna and flora. The questions spontaneously arise : Is it possible that the days and nights in high latitudes were then as they are now ? Must not the climate have been warm in January as well as in July ? Must not the influences of the solar rays—the actinic force—have been distributed through the year with at least approximate uniformity in high as well as low latitudes ? It is these questions, as well as those of temperature, that I shall consider in this paper. I propose to study the record left by the plants and animals which lived in those remote days. Some of their more obvious teachings are startling enough. Regions where now vegetation is of the scantiest character, where no trees exist save a few dwarf willows, where the winters are cold almost beyond endurance, were, as late as

* Read before the New York Academy of Science.

the Miocene, covered with magnificent forests of magnolias, oaks, cypresses, and a hundred other species. In more remote periods they abounded in plants and animals, whose fellows of identical species lived at the same time,* or at least in the same geological period, near the equator.

These statements are so extraordinary that they need to be established by unanswerable evidence. Of this there is a great abundance.

In latitude 81° 40′ Captain Nares found the remains of corals in vast quantities. These creatures require not merely a warm but an equable temperature. Those of to-day can not live where the temperature falls below 66° Fahr. Sir Charles Lyell says: "The same genera, and to some extent the same species, of Ammonites are found in those high latitudes and in India. Remains of a large ichthyosaurus were brought by Sir Edward Belcher from latitude 77° 16′. Others were found by the Swedish expedition in Spitzbergen, latitude 78° 10′." In Dana's "Manual of Geology," under the heading "Climate," in all the early periods, abundant illustration is given of the uniformity of climate in high and in low latitudes. On page 181 he sums up in these words: "No marked difference between the life of the primordial period in warm and cold latitudes has been observed"; and again, on page 253, "The living species, from 30° to 80°, were in part the same, or closely allied."

It is unnecessary to multiply proofs. All geologists agree that, all over the world, the plants and animals of any particular horizon were exceedingly alike, and very often identical. The living species to which they are most nearly allied are peculiarly sensible to changes of temperature.

So far, therefore, as it is possible to judge the past by the present, the fossils indicate a warm and uniform temperature almost to the poles, such as is now found in regions inhabited by similar species. Geologists are forced to this conclusion. In that wonderful work, Professor Dana's "Manual of Geology," it crops out everywhere: Page 266, "There is no sufficient evidence of cold arctic seas"; page 289, "There was little difference of temperature between temperate and arctic seas." (See pages 352, 452, 480, 488, 514, 521, 526, etc.) All tell the same story. "No zones of climate." Warm arctic seas all the year round.

It may, however, be thought that no very certain conclusions can be drawn from these facts, because the identical species which flourished in those remote times are no longer extant, and perhaps they

* It is of small importance, in reference to these questions, whether Huxley's "Homotaxy" is true or not. If true, then these same species lived first in high latitudes, and afterward in low, or *vice versa*. The important point for my present inquiry is, that the same species lived and flourished in places where life-conditions now are so extremely unlike.

were not so sensitive to cold as are their closely allied successors. There is some force in this, but we must not give it too much weight, for all progress in knowledge of the world's history is based upon the belief that, in general, corals in Palæozoic times indicate such conditions as exist where we now find corals; saurians, where we now find saurians; tree-ferns where we now find tree-ferns; and so of other organisms. As soon as we leave this principle, we are at sea without a compass, and almost without a star to guide us. There is direct evidence of the warmth of climate in the Tertiary, and, if this be established, there will hardly be dispute as to the climate of the earlier periods. Plants of living species which require not only a mild temperature, but one of great evenness, have been found in very high latitudes. In Spitzbergen, latitude 78° 56′, there have been found the remains of a Miocene flora remarkable for its variety and luxuriance. One species, *Libocedrus decurrens* (Heer), now lives with the redwoods of California; another now occurs in the Andes of Chili; while a third, according to Dr. Gray, is the common *Taxodium*, or cypress of the Southern States. In Greenland, latitude 70°, were found magnolias and zamias.* All these require not merely a warmth *but an evenness of temperature* that in such high latitudes is extraordinary; extraordinary and incomprehensible, if then, as now, the solar heat was wholly shut out for more than four months. It will help to realize the difficulty of a uniform climate in regions 75° to 85° from the equator, if we consider what now would be the effect of a four months night covering the torrid zone, and remember that the cold of arctic countries is not due to their position, but to the absence of the sun's rays caused thereby. The accumulated heat of summer, great as it is at the equator, would soon be radiated into space, and, when the sun returned, not a living plant or animal would remain to greet it.

The effect would be no less fatal if the long nights occurred in a zone extending, say, 20° north or south of the Gulf States. Consider the effect produced now by a slight lengthening of the night, and then say how complete would be the destruction if the night's duration was increased from a few hours to four months!

In geological times, if the axis of the earth had its present obliquity, the midwinter nights in Spitzbergen, where the plants I have mentioned were found, were four months long. The resulting changes of temperature must have been very great. At the present time they are enormous. Captain Nares † says that the thermometer at his winter quarters fell in March to $-73 \cdot 7°$. For thirteen consecutive days it showed $-59°$; for over five days $-66\frac{1}{2}$.° The variation between that and summer must be something enormous, for Mr. Meech has shown in his paper on "Solar Heat," published in the "Smithsonian Contributions to Knowledge," that the amount of heat from the sun received in high-

* Dana, "Manual of Geology," revised edition, p. 526.

† Captain Nares's report in "Nature," vol. xv, p. 35.

latitude regions, during the three middle months of the arctic day, is greater than is received in the same time at the equator.

In Dr. Kane's "Arctic Exploration," we read that the difference between maximum and minimum (summer and winter) temperature, in latitude 78° 37′, was 120° Fahr. At St. Michael's, latitude 63½°, the thermometer ranged from +76° to −55°, a variation of 131°. It would, I think, be a moderate estimate, should we attribute at Spitzbergen a variation of 100° to the changes in the sun's declination, or, in other words, to the obliquity of the earth's axis.

The cold undoubtedly was greatly modified by the latent heat of the surrounding ocean, and by the inflow of ocean-currents. But the same capacity for giving off heat exists now, and the same currents continue to flow; yet in Spitzbergen—a not large island, surrounded by a broad expanse of water—the cold is very intense. The specific heat of water has undergone no change; so far as that is concerned, the surrounding ocean does as much now, as then, to make the Spitzbergen winters mild.

Did the Gulf Stream, or the Japan Current, in those remote times, have a greater flow than now? Their effective cause is the difference between polar and tropical temperature. If this was nothing, the flow would be nothing. In geological times the difference of the temperatures must have been small, since the same species of plants and animals extended from the tropics to as near the poles as has been explored. Hence the flow of these streams, to say the least, could not, in those times, have been greater than it is at present.

Whether 100° is an overestimate of the difference between the summer and winter temperature at Spitzbergen, due to the long days and nights, it is certain that the sun produces a great effect upon the temperature in high latitudes. Whatever other thermal influences may have existed in the Miocene, or in other and earlier periods of geology, their effect was no greater in winter than in summer. Admitting it to have been the same—a matter of great doubt—the temperature, as the nights grew longer, must have fallen until it reached a point at which the loss of heat, by radiation into space, was just equal to that brought in by the ocean-streams, and by such aërial currents as might blow from warmer regions.* In summer there were the same sources of heat plus a sun shining not twelve nor fifteen hours, but for months. Calling the winter heat A, and the increment from the sun B, the heat during summer equaled A plus B. The difference at the present day between the temperature of arctic seasons is enormous. It is difficult to see how it could have been so reduced as to render life possible for plants whose fellows of the same species were, at that very time, growing in regions thousands of miles nearer the equator.

* Stellar heat need not be considered, as it does not vary, and, besides, it is very small.

The fact of their continued existence, not dwarfed and scanty, but with greatness of size and luxuriance of growth, seems to indicate that there could not have been a total cessation of solar heat for months in winter, and an uninterrupted influx for months in summer. In other words, the evidence of plants and animals points to the absence of present long days and nights.

However it may be, as late as the Tertiary, geologists are agreed that at least to the end of the Palæozoic there is a lack of any indications of zones of climate,* or, to put it in another form, that there is evidence only of evenness of climate.

I next inquire, What is indicated as to the length of the arctic day by the effects of light upon plants?

In all discussions of these curious facts—at least so far as I have seen—no attention has been paid to the effect upon vegetable and animal life, of the great difference between the length of the days and nights in high and low latitudes, even though the temperature were kept up. In Spitzbergen, for example, the sun shines uninterruptedly for four months, and for an equal time its rays are cut off, while in tropical regions a day of twelve hours is followed by a night of the same length. In the temperate zone the day is at most but a few hours longer. If the earth's axis in preglacial times was inclined $23\frac{1}{2}°$, the same inequality prevailed then. Light is as necessary to plant-life as heat, and, in respect to the character of the polar day, its evidence is more important, since light is affected only by the inclination of the earth's axis. The flow of the Gulf Stream, the lay of the land, or the relative amount and arrangement of the land and water—matters of great moment when considering questions of temperature—have no effect whatever upon the length of the day, or, in other words, upon the mode of light distribution.

Mr. Darwin and his followers have called attention to the influence of environments in destroying old species and in the production of new. In view of all that they have established, it seems incredible that species identically the same could have lived and shown luxuriant growth, say in Spitzbergen and Florida, through thousands and millions of years, unaffected by such difference as now exists in the length of the days and nights. The arguments against the reality of such a difference become stronger when we reflect that in both high and low latitudes there were from period to period enormous changes in species, old ones passing away and new ones appearing, not once, nor twice, but a great many times, and yet at each epoch the new species,

* Dana's "Manual of Geology," third edition, page 352, says: "If we draw any conclusions from the facts, it must be that the temperature of the arctic zone differed little from that of Europe and America. Through the whole hemisphere—and we may say world—there was a genial atmosphere" (and corresponding conditions as to actinic influence) "for one uniform type of vegetables, and there were genial waters for corals and brachiopods."

from the shores of the Arctic Ocean to the coasts of Bolivia, were everywhere largely the same; always enough of identical species to show that arctic and tropical environments were essentially alike. It seems, if possible, still more incredible that in later times—say, in the Miocene—species which originated in Spitzbergen and upper Greenland could migrate to low latitudes, and still show no change in specific characters.

It certainly was to be expected that conditions so unlike—I refer, now, only to the long days and nights—should have been attended by widely diverse plant-life.

The belief that such would have been the case is strengthened by the fact noticed by Mr. H. C. Watson, and quoted approvingly by Mr. Darwin in his "Origin of Species," that, "in receding from polar toward equatorial latitudes, the Alpine or mountain floras really become less and less arctic."

But, were they truly arctic, and identical with those now in Spitzbergen, such floras, accustomed to a hibernation of nine months, might well be indifferent as to where that time was spent, whether in the cold and continuous darkness of an arctic night, or in the cold of a winter on a low-latitude mountain-top. On the other hand, the plants, e. g., of the Carboniferous, were not arctic plants, but were warm-temperate, if not tropical, and there was no arctic cold, but "a warm, moist, equable atmosphere," * in which they "flourished luxuriantly." † Another corroborative fact is found in the peculiar structure of certain post-glacial arctic trees. A conifer, found standing in latitude 72½°, and of post-glacial origin, was brought to England by Sir E. Belcher, where Sir William Hooker made a microscopical examination of its structure. He found that it differed remarkably from any other conifer with which he was acquainted. Each annual ring consisted of two zones of tissue: the *inner zone was narrow, of a dark color*, formed of more slender, woody fibers, with few or no disks upon them; the outer zone was broader, of a pale color, and consisted of ordinary tubes of fiber of wood marked with disks such as are common to all coniferæ. These characters he found in all parts of the wood. They suggest, as he says, the annual recurrence of some special cause that modified the first and last formed fibers of each year's deposit, and this cause, he thinks, is found in the peculiar conditions of an arctic climate, where the days were at first very short, a few hours only of sunshine. Then the first and imperfectly developed fibers were formed. As the days grew longer and longer, and the solar rays at last became continuous, the woody fibers became more perfect, and were studded with disks of a more highly organized structure than are usual in the natural order to which this tree belongs.‡

Since Spitzbergen is nearly 5° farther north, such or similar effects ought to show themselves there in greater intensity in the conifers of

* Dana. † Lyell. ‡ See this account in Croll's "Climate and Time," pp. 264, 265.

early geological times, if the same causes then existed. Whether they have been specially searched for, I do not know; but their absence, if established, would strengthen the conviction that the conditions of arctic climate which produced such a peculiar mode of growth did not exist in the time—many thousand years earlier—when libocedrus, magnolia, and zamia were denizens of high latitudes.

There are other facts whose tendency is in the same direction.

It is admitted by all that the climate in the earlier geological times and down to the end of the Miocene was warm through the whole year. If, therefore, the earth's axis was then inclined $23\frac{1}{2}°$ as now, the plants of Spitzbergen and other high latitudes must have spent during every year of their existence more than four consecutive months without a ray of sunshine, and surrounded by an atmosphere moist and warm.

Their condition resembled that of plants in a warm, dark, and moist cellar. Modern vegetation so placed soon bleaches and dies. Undoubtedly it was possible for a specially adapted flora to exist under such circumstances. And a special flora is what we should expect. But the flora of Spitzbergen was not special; it was cosmopolitan in all the earlier periods, and in the Miocene some of the identical species flourished there with "amazing luxuriance," whose descendants, with specific character unchanged, are now found in the Southern States of our own country. It seems to me that this is presumptive evidence, if not demonstration, that as late as the Miocene the long arctic nights were unknown.

Moreover, this very luxuriance of foliage, which so surprised Lyell and other geologists, tends to the same conclusion. It is a matter of common observation that plants exposed to the full force of the sun's rays have smaller leaves than others of the same species which are somewhat protected. It would seem as though Nature compensated for the inferior intensity of the solar action by giving more surface to be acted upon. Now, since the intensity of the sun's rays varies as the cosine of the latitude, it is evident, in case the sun underwent no change in declination, that, while the length of the day in Spitzbergen and Florida would be the same, the intensity of the light in the latter would be almost double. Hence, if the earth's axis really was nearly or quite perpendicular, with the same conditions as to moisture and warmth, we ought to look for greater breadth and length of leaves in Spitzbergen than in regions much farther south, and we find them.

I know of but one fact in the geological record which seems to point to the existence of changing seasons. Fossil exogenous trees of very early times have been found with well-developed growth-rings, and, as these are usually attributed to seasonal changes, it has been said that they prove the existence of seasons; and, as these are due to the obliquity of the earth's axis, any inference to the contrary from other facts must be wrong. But growth-rings do not of necessity indicate

summer and winter. They may occur several times in a summer, or not at all, or once in several years, or where there is absolutely no change of seasons. I have seen a hard and woody stem of *Chenopodium album*, not more than four months from the seed, in which were eight well-formed rings. Dr. Gray says there is "a woody *Phytolacca* which makes at least twice as many layers as it is years old," and that cycads require several years for one layer. The orange and lemon, in green-houses, where seasons can hardly be said to be known, form rings as well defined as those of our forest-trees. On the Amazon, as may be seen in a collection of woods now in Vassar College, the rings are very apparent in some species, while in others equally exogenous none can be seen. The mangrove, which grows in the tropics on the sea-shore between high and low water mark, where by no possibility can there be any annual change either in temperature, or from wet to dry, has the rings well developed.* These facts suffice to prove that the existence of growth-rings is independent of the existence of seasons.

I think it must be admitted that the teachings of geology are in harmony with what would have been the climatic conditions in high latitudes if the axis of the earth was then perpendicular (or nearly so) to the ecliptic, provided that in some way the temperature could have been kept up sufficiently. And, if there be anything in the influence of environments, the lack of results corresponding to days and nights so different as those, e. g., of Spitzbergen and Florida, is evidence that the days and nights in those countries did not differ then as they now do. If there was no such difference, the earth's axis then did not incline as it does at the present day.

The tilting of the earth, or, in other words, changing the direction of its axis—if gradual—would occasion no perceptible disturbance. Hence no conclusion is to be drawn from the absence of traces of such a cataclysm as would have attended a change of the geographical position of the poles. The latter, however slowly brought about, would have necessitated a change in the position of the equatorial protuberance, or, if the crust was too rigid for that, a change in the ocean sufficient to overwhelm the land. The only possible effect of an increase in the obliquity of the axis would be an increase in the length of the days and nights in high latitudes followed by corresponding climatic changes. These would have registered themselves in the plants and animals of high latitudes, while near the equator the effect would be scarcely perceptible. Days and nights in low latitudes would be only slightly affected, consequently animal and vegetable life would continue as before. It is corroborative of such a tilting, that the plants and animals in high latitudes, which, till near the end of the Tertiary,

* See "American Journal of Science," 1878, Article XLV, "Is the Existence of Growth-Rings in the Exogenous Plant Proof of Alternating Seasons?" by the present writer.

had been the same as in low latitudes, became wholly changed to new species after the Tertiary, while those in low latitudes remain as they were in general character, and, in some cases, the identical species yet survive.

In our Southern States, for example, the flora is closely allied to, and as to some species identical with, those of the Miocene of arctic regions. From the Miocene back, the geological record tells of life-conditions—environments—the same all over the world.

So far, therefore, as geology is concerned, the evidence appears to be all one way, and I think I am justified in saying that the conclusion to which it points would be readily adopted, were it not for reasons derived from another science.

Astronomers say that a permanent change in the inclination of the earth's axis by means of any force known to science is impossible. We know, however, very little of the means by which our system was brought into its present state.

The only theory that attempts to explain, on purely mechanical principles, the existence of the solar system is the nebular hypothesis in some of its forms, although even that requires a self-existent entity back of it. According to this hypothesis, the earth and moon were once one body, which revolved, of course, on one axis. At some remote time a separation occurred. But no force of avulsion, whether the moon was merely left behind as the mass contracted, or whether, as Mr. Darwin thinks, it was thrown off after the earth had become solid, and pushed back to its present distance, could affect the plane of rotation, or the direction of the axes. On mechanical principles, the moon when it left the earth must have moved in the plane of the earth's equator, and the three axes—that of the earth, that of the lunar orbit, and that of the moon itself—must have been parallel to each other. But such is not the case now. The axis of the moon is inclined about $1° 30'$, that of its orbit $5° 9'$, and that of the earth $23\frac{1}{2}°$. It is evident that at some time the axes, or some of them, have undergone a change of direction. On purely mechanical principles, the change did not occur before the earth and moon separated, nor at the moment of separation, nor, in fact, at any time.

Astronomy, therefore, proves too much! It proves that the present condition is not eternal; that the earth was not created with its present oblique axes—in fact, that normally it was perpendicular to the ecliptic; and that, once in any position, it was impossible for it to become more oblique "by any force known to science." To all of which those of us who are not astronomers can only answer: "What you say may all be true, but, nevertheless, the earth's axis is inclined, and, if we can not show the cause—an inability which extends to a great many other things—our business is to discover, if we can, the time when it became inclined. It is not a question of possibilities, but of chronology."

The fact that the earth's axis has a different obliquity from that of the moon proves that a change occurred in the one or the other after their separation ; and, since the moon remains so nearly in the normal position, it must have been the earth that was changed. The uniformity of biological conditions in all latitudes indicates that the present obliquity had not been attained in Archæan time, nor in Palæozoic, nor in Mesozoic, nor in the Eocene, nor in the Miocene, nor in the earlier Pliocene ; then comes a blank during which the Glacial epoch came and went, and, when again the record begins to be legible, there are, for the first time in the world's history, indications of alternating seasons.*

In view of all these facts, it seems most probable that, in that blank interval, the Glacial epoch, or, more largely, between the end of the Miocene and the beginning of the Champlain, that movement occurred which gave the earth seasons, unequal days and nights, and greatly enlarged its limits of inhabitability.

It requires no argument to show that an axis nearly perpendicular would account for the otherwise inexplicable evenness of geological climate. Although the Gulf Stream, or other currents, might bend the isotherms, the temperature at any point would, with such an axis, have remained constant. The conditions as to light and actinic force would have been the same everywhere, save the variation due to greater or less latitude. All this, however, is compatible with great cold ; hence it remains to inquire why the polar climate was so warm. Many theories have been advanced to solve this problem. I have neither space nor time to discuss them now, and will only say that six or seven of the earlier ones are ably treated by Searles V. Wood, Jr., in the "Geological Magazine" for September and October, 1876 ; also by Dr. Croll, in his "Climate and Time." Dr. Croll's own theory I have discussed at large in "The Three Climates of Geology" ("Penn Monthly," June, July, and August, 1880), and have there pointed out what seem to me insuperable objections to it.†

Professor Whitney has lately put forth another theory, attributing the early warmth to the sun itself being hotter in geological times

* There probably were zones of climate in the latter half of the Tertiary, or at least in the Pliocene, but these are quite compatible with the absence of seasons, since, with a perpendicular axis, temperature, however it might differ on different parallels, would be constant in each.

† Since writing the above I have read Professor Woeikof's article in the "American Journal of Science" for March, 1886, entitled "An Examination of Dr. Croll's Hypotheses of Geological Climates." It is a careful testing of Dr. Croll's theories by applying them to present facts, as to summer and winter variations of climate. He shows that no such differences exist as Dr. Croll's theories demand. He sums up his conclusions (page 178) as follows: "The main points on which rests, so to say, the whole fabric in its explanation of glaciation and geological climates generally—the influence of winter in aphelion and in perihelion—during high eccentricity, and the calculation of temperatures in proportion to the sun-heat received, are unfortunately fallacious." The article will well repay the student of geological climate for its careful study.

than it now is. All conclusions, however, in regard to the sun's former temperature must be hypothetical; but, if it be a gaseous body, as suggested by Professor Young, it has been growing hotter all the time it has been giving out heat.* To this, as to all other theories heretofore advanced, there lies the serious objection that they ignore the world-wide uniformity of light and actinic force, and no theory that fails here can be satisfactory.

A perpendicular axis alone does not account for the warmth in polar regions. On the contrary, with such an axis, they would receive during the year less heat than they now do, and hence Dr. Croll infers that a perpendicular axis would make the polar climate less genial. This is true, if temperature depends solely on the amount of heat received. But, as every one knows, it depends far more upon the amount retained. Green-houses and drying-houses are often uncomfortably warm when the mercury without indicates a temperature near freezing. The solar rays readily enter through the glass, and are absorbed by the floors, walls, etc., while the heat radiated back is unable to escape. Many substances possess this property, and Professor Tyndall has shown that among them are carbonic acid and aqueous vapor.

In the present state of our knowledge, it is impossible to form even an approximate estimate as to the actual amount of carbon stored in the earth's crust as graphite, coal, lignite, bitumen, petroleum, etc., but it must be many times—probably many hundred times—greater than that now remaining in the atmosphere. All these forms of carbon are directly or indirectly of vegetable origin, and hence it once existed in the form of carbonic acid. It has been said, however, that so much CO^2 was not found in the air at any one time, but that it was given out by volcanoes just about fast enough to take the place of that which was stored in the earth's crust. But, as Professor Dana remarks, volcanoes do not originate this gas; they give it out only as their fires come in contact with limestone, and this occurs but rarely now, and was still more uncommon in Palæozoic times.†

It appears, therefore, that at some remote period all the carbon which has since been a portion of animal or vegetable forms, existed as free carbonic acid, and formed a part of the then atmosphere. With the beginning of plant-life a process of elimination commenced. It continued till about the close of the Tertiary, when the amount taken out by living forms and that restored to the atmosphere by decomposition became equal—a condition which still exists.

The CO^2 is now diffused with great uniformity over the earth, and,

* For proof of this curious paradox, discovered by Mr. J. H. Lane, see "American Journal of Science," July, 1880; also, Newcomb's "Astronomy," p. 508.

† "Manual of Geology," p. 363. Some think that there has been an accretion of CO^2 from interstellar space. This appears to be too hypothetical to seriously affect the argument.

for lack of reason to the contrary, we must believe that it was equally uniform in geological times. It acted as glass does in a green-house; it retained the heat radiated from the earth's surface, and consequently caused a rise in temperature. This increased in a higher ratio the capacity of the air for water, and that in its turn aided still further in retaining the heat, and of course made the climate warmer. In this, I think, lies the secret of the warm climate in high latitudes in those early times, the otherwise cold polar regions being protected by this double "blanket." The effect of such a covering is well set forth by Professor Tyndall in "Heat considered as a Mode of Motion," pp. 405, 406. I quote only one sentence: "The removal, for a single summer night, of the aqueous vapor which covers England would be attended by the destruction of every plant which a freezing temperature could kill."

In contrast with this, I add one illustration of the temperature possible were the earth covered with a "warm blanket" equal in heat-retaining power to glass. I quote from Professor Langley's summary of work on Mount Whitney to ascertain the amount of heat the sun sends to the earth: "On the summit of Mount Whitney the temperature in a blackened copper vessel, covered by two sheets of common window-glass, rose above the boiling point. With such a vessel water could be boiled in the snow-fields of Mount Whitney by the direct solar rays."

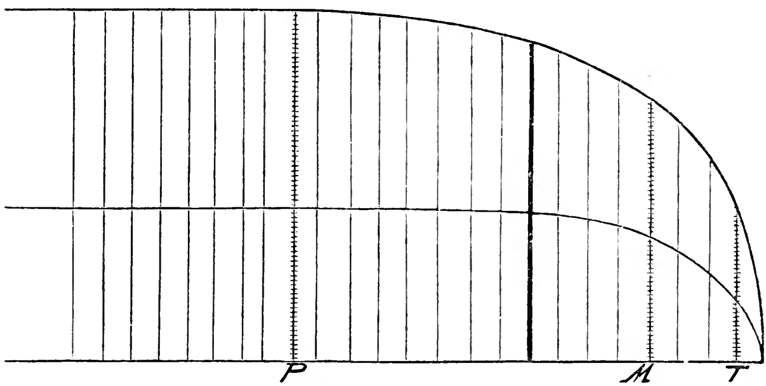
Besides carbonic acid and water, there probably were in the early atmosphere other gases and vapors. Ammonia would produce thirteen times the effect of CO^2 at the same density, and marsh-gas four and one half times, and so of others ("Heat as a Mode of Motion," p. 362). Whatever there was of these, their influence tended to increase the "warm blanket." The amazingly slow change of temperature in the early periods finds a reasonable explanation in the effect of those gases and vapors in the atmosphere.

Professor Tyndall has shown that, commencing with a vacuum, and adding a small number of very small increments, the absorption is sensibly proportional to the increments, but, as the quantity increases, the deviation from proportionality augments (idem, p. 356); at length a condition is reached in which further increments produce very little effect. The converse must also be true. Commencing with a great amount of the gas, or vapor, a very great number of decrements will be needed to produce any sensible effect; then a smaller number, and so on, until toward the end, and then the decrement needed will be very small, and the effect comparatively large.

The following diagram, made from a table on page 35 of the same work, shows this more clearly. The curved line indicates temperature for equal increments of the gas.

The diagram is for sulphuric ether and olefiant gas. All other (compound) gases and vapors observe the same law, but differ in the

rapidity of descent of the curve. The abscissæ correspond to the equal decrements in equal times; the ordinates, to the fall in heat-retaining power. Up to the heavy line, counting from the right, the ordinates are proportional to the numbers in Professor Tyndall's table (page 354), which were obtained by measurements. The others are estimated by continuing the curve to the left. If we suppose the first abscissa on the right represents the Tertiary, the next three will represent the Mesozoic; the next twelve the Palæozoic, and an unknown number beyond will represent the Archæan.



THE UPPER CURVE IS FOR THE ETHER, AND THE LOWER ONE FOR OLEFIANT GAS.

All that is known about the changes of temperature in the geological climate is derived from observing the changes in the plants and animals. These changes were world-wide, and hence were due to a world-wide cause. None sufficiently broad has been imagined other than a change of temperature, or a change in the purity of the atmosphere. The peculiar life of the Palæozoic lasted several times as long as that of the Mezosoic; and that, in turn, lasted several times as long as that of the Tertiary. Or, calling the last 1, the ratio was 12 : 3 : 1. The millions of years of the Palæozoic brought a certain increase of purity and decrease of temperature, and were followed by an almost complete extermination of species, owing to their non-adaptation to the new conditions. The Mesozoic, although only one fourth as long, brought probably quite as great a change, and was followed by "one of the most complete exterminations on record." Through the Eocene and Miocene, although not more than one fifteenth as long as the preceding, the fall of temperature was actually greater than in them all combined, and this was far exceeded in the rest of the Tertiary, for, in the Miocene, cypresses and magnolias grew within 10½° of the pole, and, at the end of the Pliocene, that dread winter began to set in which is known as the Glacial epoch. There was a correspondingly rapid change in the plants and animals. Whether it is a matter of accident, or whether they stand in relation of cause and effect, the

record of life is such as it would be if the warmth were due to a blanket of carbonic acid and water-vapor, and the temperature fell in accordance with Tyndall's law.

It is also very suggestive that, while, in the earlier periods, the changes in plants and animals were world-wide, the Tertiary changes were more and more confined to high latitudes, as if the cold were setting down from the poles toward the equator. Such was the effect to be expected if the early warmth was due to the warm blanket of CO^2 and aqueous vapor. If that was growing thinner, it would be long before any sensible effect would be produced ; but, when it did appear, it would first manifest itself near the poles, where less solar heat was received, and where so much depended upon the heat being retained, and from the polar regions it would spread toward the equator. With these facts in view, there is no difficulty in seeing why the flora of temperate or even warmer regions should have had their origin in very high latitudes, since it was there that a temperature first appeared which was adapted to their needs.

I have purposely avoided speaking of how much CO^2 the air can contain and support life. I doubt very much the possibility of saying what the limits were in those remote times when not merely every species, but every genus, was exceedingly unlike any now living. They may have been adapted to conditions fatal to any creature known to us. It is certain that as the air grew purer the early animals died, and were replaced by others more like those now living. Present animals, or even human beings, according to Professor Remsen, of Johns Hopkins University, can breathe an atmosphere containing five per cent of carbonic acid "without experiencing serious or even disagreeable effects." That is, the present amount of CO^2 could be increased one hundred and fifty times, and more, without "even disagreeable effects." If this be true, the fact that the animals of those early times flourished, is no reason why we may not believe that the atmosphere contained many hundred times as much carbonic acid as it does now.

Accounting for the uniformity of biological conditions, including in that term heat, light, and actinic forces, solves only a part of the climatic problem. The cold which followed must also be accounted for, as well as the return of a mild climate to regions so long covered with ice. The former was a corollary of the causes already discussed. It was due to the combined effect of a perpendicular axis and a purer atmosphere, aided by those high latitude uplifts which occurred at or soon after the close of the Pliocene. The warm blanket being removed, the natural effects of an upright axis began to show themselves. It was the same as if the sun got no farther north than it does now on the 21st of March. Since the cold of the vernal equinox is in part the residuum of winter, it will be near the truth to say that, with the axis perpendicular, the temperature would be the same as now in April. The present flora would die out, and it would

not be necessary to go far to the north to meet perpetual snow. For snow once fallen, or ice once formed, would never melt, but, accumulating through the ages, would force its way by its own weight equatorward until it reached a region where the heat of the sun was sufficient to melt it away. The uplifts in high latitudes intensified the results. *Vice versa*, when the axis became oblique, more solar heat fell within the polar circle, those regions became warmer, and the Glacial epoch departed. If these conditions—a perpendicular axis and high uplifts—could be to-day restored, the atmosphere remaining as it is, the Glacial epoch would return.

The removal of the ice was hastened by the depression of high-latitude lands. This depression was very extensive. Vast tracts were submerged. In this is found, I think, the cause of the mild climate of the Champlain, while the cold (the minor Glacial epoch) that followed was due to another upward movement, or movements, comparatively limited in extent—in fact, confined mostly to Europe and Asia.

Subsequent changes left us the climate of to-day.

In the briefest possible space, I sum up as follows:

The uniformity of plant-life, regardless of latitude, to near the close of the Tertiary, indicates uniformity of biological conditions—i. e., of light, or actinic force, and heat.

The former indicates that the earth's axis was approximately perpendicular—a conclusion in harmony with the belief that the moon and earth were once one body, and consequently that their axes were originally parallel.

The uniformity of temperature in high latitudes through the year is also accounted for by a perpendicular axis, and, so far as I can see, only by that.

Astronomy tells only of present conditions. As to how or when the axis took its present obliquity, it is unable to say.

Geology fixes the date by the record which solar influences have left on organic forms, and places it near or just after the close of the Tertiary.

The warmth of arctic regions—for there might have been uniformity without warmth—was due to the "double blanket" of carbonic acid and aqueous vapor.

The cold of the Glacial epoch was due to the loss of CO^2 and aqueous vapor, aided by high-latitude uplifts.

The disappearance of the ice and cold was due to the earth's axis being made to incline as now, and to the reduction of the uplifts.

The warmth of the Champlain was due to depression of the land.

The second or minor ice period was due to another uplift confined to (or at least much greater in) Europe and Asia.

The depression of the land to somewhat near the present level, with present amount of CO^2 and H_2O in the atmosphere, resulted in present climatic conditions.

The influence of gases and vapors upon climate was to some extent considered by its eminent discoverer, Professor Tyndall, and I presume by every one that has read his account of his experiments on the passage of heat through these bodies. Theorizers on climate have been fond of changing the earth's axis, confining themselves, however, for the most part to altering the geographical position of the poles—i. e., increasing one set of latitudes and decreasing another, to suit their needs; and a few have invoked an increased or a decreased obliquity.

The present explanation differs widely from all that have preceded it, and in its entirety has the merit of novelty, whatever that may be.

ANIMAL AND PLANT LORE OF CHILDREN.

By Mrs. FANNY D. BERGEN.

OUR modern scientific methods of education are slowly correcting hosts of popular errors regarding every-day subjects of observation, and doubtless a succeeding generation will have outgrown many queer conceits and myths now held as facts by the great majority of country children. It will hereafter be interesting to have preserved a full record of such misapprehensions. The wish to add a trifle to such a record has led me to note some common superstitions concerning animals and plants, which have come under my own knowledge. Children have quick perceptions, and therefore are good observers or seers. The observations they make, however, regarding the animals and plants about them, while often in themselves quite accurate, lead to very incorrect conclusions. This is because children do not reason deeply. It takes a long time for them to learn that not once or twice, but a great many times, must one phenomenon follow certain other preceding phenomena to warrant the use of the logical terms *effect* and *cause.* Caution in forming deductions comes only with experience and education. Children have keen eyes for any strange peculiarities as well as for real or fancied resemblances, and are quick to appreciate the qualities of plants. An enthusiastic botanist and teacher, speaking of children, said, "They bow as to some fetich before poisonous plants." Monstrosities in Nature fascinate them. Double apples, strangely shaped knots from trees, grotesque roots, curious lichens adorn many "play-houses." Their readiness to get hold of the properties of plants explains how it is that children (boys particularly, because they are more in the out-door world) find so many things to eat in the woods and fields. A boy accustomed to tramp about will seldom go a hundred rods afield before he begins to nibble or chew something that he finds growing in his path. Can you not recall a dozen wild things of which you were fond in childhood

which long ago passed from your list of edibles? Sassafras-bark, both of twig and root, spice-wood, "slippery-elm," the buds of the linden-tree, the tender shoots from the spruce and larch, all tickle the palate of the boy or girl. Men whose boyhood was passed anywhere in Northern New England may recall how fond they once were of something which was called "sliver," the cambium layer of the white pine. In certain places it is the fashion to chew the leaves of the Antennaria, "Indian tobacco"—in others, thistle-blossoms. Will ever honey taste as sweet as did the dainty droplets taken direct from some unfortunate bumble-bee captured and dismembered by the boy seeking what he may devour? The tubers of the squirrel-corn and root-stocks of the pepper-root are sought after with a diligence deserving of a treasure. The birds are not the only harvesters of the pretty moss known as robin-wheat.

The numerous observations, then, of children, regarding the appearances and properties of plants and animals, give them a wide-spread series of premises, chiefly of a practical character, from which to draw inferences. Children are proverbial for asking questions, whose depth is often astonishing. Their eagerness to have their inquiries answered often leads them to take their own hasty, illogical inferences for correct answers, though they may really be quite absurd. Their natural credulity makes it easy for children to accept as a fact any notion once formulated; hence many of their superstitions may have arisen. Some of these are shared by ignorant people of mature years, who, intellectually speaking, are but children. Beliefs of this mythical nature vary somewhat with locality, but certain of them have become crystallized, as it were, and grown to be common property, and are as generally accepted by country boys and girls as any theological dogma among their elders.

The snake-tribe has given rise to an unusually large number of superstitions. Among peoples of every degree of civilization and of all times, from the dawn of history to the present day, some form of serpent-worship has prevailed. This is not improbably due to the air of mystery which attaches to the stealthy movements of the animal, and to the awe-inspiring effect of the bite of poisonous snakes. And, just as serpent-worship prevails most among savages to-day, so among civilized peoples, children, most of all, feel a fearful, superstitious interest in all that concerns snakes, and have invented many myths about them. In Central Ohio, when one child kills a snake, the lookers-on universally call out, "Its tail won't die till sundown." This notion, I find, is one of wide acceptation, and doubtless arises from the persistent vitality of the muscular contractility of the snake. In Southern Ohio it is now generally believed that a snake will not crawl over ash-wood; and a man over eighty years of age tells me the same belief was common in Massachusetts when he was a boy, and he thinks it is by no means yet extinct. In certain localities in Massachusetts

a reputed final cure for toothache is to bite into a living black-snake. An old saying—

> "Break your first brake,
> Kill your first snake,
> And you'll conquer all your enemies"—

is often recalled by the first snake one meets in the spring, or at sight of the earliest fern. I find few children can be persuaded that our common snakes are not "poisonous." And here and there throughout New England it is believed that the common water-adder (*Tropidonotus sipedon*) is most venomous, and that it carries "a sting in its tail"! This fictitious appendage of the adder suggests the remarkable hold that the belief in "hoop-snakes," and their extraordinary gymnastics, has obtained in many of the remoter and more heavily wooded portions of the country. This imaginary creature is said to have a sting in its tail, which, when about to make an attack, it takes in its mouth, so as to form a hoop, then it rolls along (by preference down a steep hill-side) toward the intended victim, whom it strikes in passing with its sting. I can find no foundation for belief in any such animal.

Some dozen years ago, while I was connected with a high-school in Northwestern Missouri, my pupils tried hard to convince me that "jointed snakes" were not uncommon there. I was told that, if one of these snakes were struck a sharp blow, it would quickly break into many pieces, which, being very brittle, were apt to fly about in different directions, so that it would be difficult to find all of them; but if left alone, after the danger was past, these scattered parts or "joints" would "crawl together," fall into order, and creep off as good as new. There was so much testimony concerning this marvelous reptile, that I was tempted to think there was some basis of truth for the belief in its existence, but, after minute inquiry, I concluded that the whole story had probably grown out of the fact that there is a certain lizard (*Opheosaurus ventralis*), popularly known as the "glass-snake," whose tail is so fragile that it breaks easily when struck. I find that, at least in one village in Eastern Massachusetts, the boys insist that, if you cut off the head of a certain kind of snake, it will grow on to the body again and the snake will live.

Another most absurd notion whose connection with the subject of snakes is, however, wholly nominal, is that horse-hairs, if allowed to remain in a pond or puddle of water, will become living creatures—"turn into snakes" is the technical term among boys, I believe, for the supposed metamorphosis. It would seem that, by way of teachers long before this, Professor Agassiz's article on this subject might have worked its way even into very provincial districts. Nevertheless, only last year, a young man in a thriving Western college earnestly supported the theory, and tried hard to convince his professor in zoölogy

that he had known of cow-hairs turning into short, thread-like worms. He probably had seen either young specimens of *Gordius* or some other nematode worm in the barn-yard and also seen plenty of loose hair lying about and connected the two facts as cause and effect.

From the time when there was an unwavering belief in the existence of a jewel in a toad's head and faith in its great medical virtues to the present day, a good many queer notions have been propagated about toads and frogs. Farmers' boys from Maine to Indiana are often cautious about flinging stones at either toads or frogs, lest their death should "make the cows give bloody milk." Throughout New England the killing of a barn-swallow is believed to have the same effect. East and West, North and South, the common name of our fresh-water *confervæ*, "frog-spittle," very generally bears a literal meaning to the country boy or girl as well as to many grown-up persons. The teacher in country schools will not always find it easy to convince her pupils that this floating green scum is a mass of growing plants. It is a very common belief that the tails of tadpoles literally "drop off" as might a loose finger-nail. Boys appreciate sufficiently a frog's strong hold on life to say "he has seven lives." I have met several children who thought that the fungi known as "toad-stools" derived their name from their being an actual resting-place or shelter for toads. I do not, however, know that this idea has any extended range. Speaking of toads, I wonder if the wide-spread but erroneous belief, that the touch of a toad will produce warts, first came about from the accidental discovery that the secretion of the glands of the skin is very acrid? This might easily have been guessed from the alacrity with which a dog will drop a toad if he has by chance bitten one. But is it not more likely that the fallacy regarding the production of warts is a result of some such theory as the "doctrine of signatures"? This, you remember, led physicians, in the infancy of medicine, to adopt as remedies many herbs quite destitute of curative powers merely because of some external characteristic which, so the doctrine supposed, indicated the disease to be cured by the use of the several plants thus employed. For this and no other reason the little eyebright (*Euphrasia officinalis*) was enrolled in the early materia medica as a panacea for diseases of the eye. The rough coat of the toad would naturally suggest the idea of warts, and a single suggestion very easily grows into a theory, and a theory into a belief.

Some reputed remedies for warts may be in place just here. In Southern Ohio the children believe that the juice of the Osage orange (*Maclura aurantiaca*) will remove these disagreeable excrescences. In other parts of the same State the juice of the tiny creeping "milkweed" (*Euphorbia maculata* or *E. humistrata*) is said to be a certain cure for warts. This latter notion I also find common in many places both east and west of Ohio; while in Eastern Massachusetts the same curative quality is thought to be possessed by the milky juice of the

Asclepias cornuti. Now, does not the fact that plants which differ so widely from one another, save in the one respect of secreting a white or milk-like juice, are alike reputed to possess this power of removing warts, probably show that this virtue is entirely imaginary and the result of the accidental similarity in their juices? With or without reason, in Eastern Massachusetts it is thought that bathing warts with rain-water that chances to stand in a yellow-oak stump will cure them. Another remedy is to rub them with a bean-leaf and then hide the latter. Or, again, steal a bean, rub the warts, throw the bean on moist earth or bury it, and, as the bean sprouts, it is supposed the warts will gradually disappear. Another "cure" is to cut a notch in a sprout of an apple-tree, rub the wart across the notch, and as the notch grows up the wart will be removed.

Those who were pupils in Western district schools twenty or thirty years ago probably remember how if a child was stung by a wasp or bee the immediate cry from the playfellows was, "Get three leaves!" "Rub it with three leaves!" And forthwith three leaves were plucked from any three plants whatever, quickly crushed in the hand and held on the bee-sting, and, no matter what leaves had been found, there was perfect faith that the pain would soon be relieved.

There is a saying among young sportsmen that, to spill shot in the first load in hunting, means "no game."

Many a half-grown lad believes that virtue is imparted to the bait by rubbing it, before casting his line into the water, with the hard callosity from a horse's fore-leg; these horny growths are therefore eagerly sought about the stable or the horseshoer's shop and are carried about in the pocket in spite of their strong scent. Another supposed charm is to spit on the bait. It is just possible that some odor lent the bait by either of these substances does attract the attention of the fish, but I have no sufficient evidence of this. In some parts of New England boys dislike to meet a lone crow when going fishing, as they say this foretells bad luck. Silence is the law of good anglers (of larger growth), but boys sometimes hope to "get a bite" by repeating over and over—

"Fishy, fishy, come bite my hook,
I'll go captain, and you'll go cook-
(ed in the pan)."

The confidence which children have in the various incantations which they repeat for certain purposes is most interesting. In different localities they utter various formulæ when an ant-lion's den is discovered. Children I knew years ago in Northern Ohio would quickly bend down over the little funnel in the sand and solemnly repeat in rather a loud monotone, "Mooly-up," "Mooly-up," until the sand began to be stirred by the creature concealed below, which doubtless was attracted by the crooning sound, and supposed it to be made by some

hoped-for victim. In another part of the same State the required call was—

"Jack, Jack, come up the world!
Bread and butter, bread and butter," etc.

I've rarely seen on canvas so interesting a *genre* picture as a *tableau vivant* one may often see, in Western farming districts, a child standing in the burning summer sun, holding securely with one hand a grasshopper, while he earnestly repeats—

"Spit, spit tobacco-juice!
Spit, spit tobacco-juice!"—

and the established rule of the children is to detain the queer, awkward little captive until as a ransom he "spits," when he is to go free. In New England these lines to the grasshopper are—

"Grasshopper, grasshopper gray,
Give me some molasses,
Or I'll cut off your head
And throw you away!"

I suppose every one knows the familiar call to the lady-bug whenever one is seen by a child—

"Lady-bug, lady-bug, fly away home,
Your house is on fire and your children will burn!"

I have wondered if this is merely a putting into words the idea of flame which is suddenly suggested by the sight of one of these beautifully colored beetles. What child can resist pulling a seed-dandelion and blowing the feathered head, "to see if my mother wants me to go home"? And plenty of children believe that holding a buttercup under the chin really indicates whether one likes butter or not. Many a little country girl thinks that the color of her next new dress is foretold by the color of the first butterfly she sees in the spring. In some places in Western States there is a superstition that, if you make a wish the first time you see a new-born calf, your wish "will come true."

One of the queerest myths regarding animals I learned from a native of Portsmouth, New Hampshire. The boys there, fifty or sixty years ago, were quite certain that, if a live coal were put on a turtle's back, the animal would come out of his shell and crawl away, leaving the latter behind him!

In some parts of Eastern Massachusetts if the children see a "daddy-long-legs," they exclaim, "Don't kill him, or it'll rain to-morrow!" In the same localities there is great faith in the good fortune brought by the capture of what they call "lucky-bugs"—the common whirligigs (*Gyrinidæ*), insects of an oval shape and blue-black color, which may be seen in swarms whirling ceaselessly about with a sort of waving motion on our ponds and streams. The notion is that if you can catch

one of these busy little fellows, bury him and make a wish, you will certainly "get your wish." I do not know how general is the belief that it is ill-luck to kill a spider or a cricket, but several persons have told me of this. As far as I can learn it is quite universal for children to feel that there is something uncanny about the dragon-fly. The common doubt and fear of the insect is vividly expressed by the child's name, "devil's darning-needle," so generally given it. It is usually thought to possess a poisonous sting, and in some places the belief is held that this winged needle will "sew one's ears together" if opportunity permit. In some localities in New England another superstition, indicated by the common name of the creature, is that there is danger that the earwig will creep into the human ear and eat out one's brains. An equally absurd and ungrounded fancy is that the mole regularly comes out of his burrow every day for a few moments at just twelve o'clock.

I have found in both Eastern and Western Massachusetts that children are fond of eating what they call "swamp-apples." This "fruit," upon investigation, turns out to be an excrescence, very frequently occurring on the *Azalea*, which is caused by the sting of an insect. One young girl told me, after I had ruined her appetite for the woodland delicacy, of which she had been very fond, that she "had thought it strange that the fruit always appeared on the plant before the flowers." "Oak-apples" or "oak-balls," the galls so frequently found on oaks, are also very often believed to be true fruits.

Many years ago in Northern Ohio I remember that among the wild flowers we children most highly prized, I suppose because comparatively rare, was one of the orchids, probably the putty-root (*Aplectrum hyemale*), which we called "Adam and Eve." Whenever this beautiful plant was found, the children at once began to look about for "the devil," as they called a third leaf, which frequently was found near by, and which was probably a new plantlet sent up by the creeping root-stock beyond the older portion of the plant.

I do not know how general is the very queer notion that an apple-sprout, planted upside-down, will produce a tree that will bear apples without any core.

In various parts of New England, when roast goose is served for dinner during the autumn or early winter, the children are eager to examine the breast-bone to see what sort of a season is foretold. If the bone be mostly dark, it is said to signify a rainy winter; but if the bone be mainly white or light-colored, then much snow is to be expected. Another New England superstition concerning geese is that wild ones in their changes of position while on the wing form the various letters of the alphabet.

As a remedy for the disease prevalent among young chickens, commonly known as "the gapes," children, as well as grown-up people, in some parts of the West, remove the little scale that is found on the

end of the bill of a newly hatched chick. It would be of more practical value did they know that the real cause was a little thread-like worm far back in the throat. This worm may easily be removed by a loop of horse-hair, or destroyed by the application of proper remedies. In the same localities I remember that when I was a child "luck-eggs," as we called the very small eggs, now and then dropped at the end of the laying-season, were highly valued by children, as they believed that so long as one of these small treasures was kept unbroken good fortune would attend the possessor. Children in some parts of New England have a very singular notion that it is the yelk of the egg which, during the process of incubation, develops into the body of the chick, while the white gives rise to the feathers. With this instance I may close the present brief account of such specimens of the animal and plant lore of children as a moderate amount of inquiry has enabled me to procure. I have mentioned approximately the regions where I knew the various superstitions were entertained, but doubtless many of them have wider range than has here been indicated. More extended research, particularly in out-of-the-way localities in the South and West, may greatly add to the list of such beliefs.

Note.—The writer will gratefully acknowledge the receipt of additional myths of similar character to those here given, with a view to subsequent fuller treatment of the subject. Beliefs of adults will be acceptable, as well as those held only by children, and it will be of service if considerable detail be given in regard to the geographical or social boundaries of the superstition, and if the latter be stated as explicitly as possible. Address Mrs. Fanny D. Bergen, P. O. box 253, Peabody, Massachusetts.

THE ORIGIN AND STRUCTURE OF METEORITES.

By M. A. DAUBRÉE.

TILL the second half of this century the nature of the innumerable stars with which space is peopled was wholly a subject of imaginative speculation. Recent science has been able to substitute more exact ideas for premature hypotheses. Notwithstanding the immense distances that separate them from us, spectrum analysis has enabled us to make chemical investigations of the sun, the comets, stars, and nebulæ. It is, further, possible to reach results more precise and more complete in other respects for many extra-terrestrial bodies; that is, for those bodies, fragments of which are dropped from time to time upon our globe. Although we have no means of going to them, they come to us, real messengers from above, to satisfy our legitimate curiosity. The study of these fragments, the only cosmic bodies which it is possible for us to handle immediately, concerns one of the fundamental questions of the physical history of the universe.

The list of meteors, both in ancient and modern times, is very full.

Some of the more remarkable falls were objects of extraordinary attention among the inquisitive but imperfectly informed ancients, and the stones themselves were invested with something like divine honors. But, notwithstanding the frequent and authentic testimonials that were given of the fall of meteoric bodies upon the earth in the course of more than twenty centuries, educated people were still incredulous on the subject not more than a hundred years ago. Inversely to the usual course, even the advance of knowledge furnished objections against the truth. The most natural supposition of an extra-terrestrial origin of the meteors appeared to contradict the immutable laws of the movements of the heavenly bodies; for those laws seemed to be inconsistent with the possibility of irregular phenomena. It was easier to deny the reality of such anomalies than to believe in them. But it will not be right to give too severe a condemnation to this persistent denial; for the fabulous and fanciful details with which the accounts of the phenomena were charged necessarily gave an air of incredibility to the whole. It was not till the end of the last century that conditions especially favorable to exact observations afforded the means of unanswerably demonstrating the existence of meteors. The recognition of them became general and complete after the showers that occurred at Benares, India, at eight o'clock in the evening of the 13th of December, 1798, in the presence of a large number of spectators; and was further strengthened after the fall at L'Aigle, France, at one o'clock in the afternoon of the 26th of April, 1803. Biot, acting under a commission of the Academy of Sciences, made a minute account of all the circumstances of the last fall.

Meteorites interest us not only in respect to the origin and the causes of their descent upon our planet, but also in respect to their constitution. It is to the last aspect that we shall pay particular attention, after giving a succinct account of the circumstances under which they come to us.

The phenomena that precede and accompany falls of meteorites, while they vary very much in their secondary details, nevertheless present a whole of general character, reoccurring with constancy at each apparition, and adequately proving that the origin of the bodies is foreign to our planet.

The first appearance is that of a globe of fire bright enough to set all the atmosphere aglow at night, or to be visible at high noon, if in the daytime. Its apparent diameter increases as it gets nearer. It describes a track whose incandescence makes it perceptible from a distance, and which is only slightly inclined to the horizon. The cosmic character of the bodies is indicated by their excessive velocity, which surpasses anything that we know of on the earth, and is in reality comparable to that of the planetary bodies. After a longer or shorter career, the body bursts with a noise which has been compared with that of thunder, a cannon, or musketry, according to the distance away

of the observer. A single explosion is rare. There are generally two or three of them. Sometimes they are violent enough to shake houses and give the impression of an earthquake, as was the case in Iowa when the meteor of the 12th of February, 1875, fell. They are often heard over a considerable extent of country, as was the case with the Orgueil meteors, the explosions of which were heard three hundred miles away. When we reflect that these detonations take place at heights where the thinly rarefied air affords a very poor medium for the propagation of sound, we become satisfied that they must be extremely violent. Sometimes a trail of vapors is perceived in the regions of the atmosphere which the body has traversed. These phenomena are manifested in the most diverse regions of the globe, at every season and every hour, and frequently in calm and cloudless weather. Storms and whirlwinds, therefore, have nothing to do with them. Their speed as observed by us being only relative, varies according to the correspondence or non-correspondence of the direction of their path with the course which the earth is pursuing.

The outer configuration of meteorites is remarkable for its fragmentary aspect, or for its angular formations and its likeness to irregular polyhedrons, the edges of which have been blunted.

The number of stones brought down in a single meteoric shower is extremely variable. Sometimes only one is found ; sometimes many ; and, in rare cases, hundreds and thousands. At the instant the stones reach us their velocity is small, compared with that which the body of which they are fragments had previous to the explosion. If they are of considerable size, they will perhaps bury themselves at a slight depth under a yielding soil, and remain there unperceived. After all the light they give and the noise they make in their flight, the minuteness of the masses which we find upon the surface of the ground is sometimes surprising. The largest one ever found—at St. Catherine, Brazil, 1875—weighed 25,000 kilogrammes ; stones of more than 300 kilogrammes, like the one that fell at New Concord on the 1st of May, 1860, are rare, while the weight of 50 kilogrammes is seldom exceeded. Often whole meteorites weigh only a few grammes, or are of the size of a hen's egg, a walnut, or a hazel-nut ; and masses of still smaller ones have been observed when they fell upon a bed of snow, as at Hersle, near Upsala, Sweden, in 1869, when many of the stones weighed only a few decigrammes, and one of them as little as six centigrammes. These little grains, it should be remarked, were not fragments broken off by the shock of larger pieces against the ground ; but each one was a complete meteorite, enveloped in a crust of half-melted matter. That so small meteors had not been noticed before is explained by the difficulty of distinguishing them from the particles composing the general surface, among which they are lost.

When the meteors of the same shower are numerous, they are generally distributed at various points within an elongated oval area, the

axis of which corresponds with the direction of the trajectory, and within which they appear to have been sifted by the resistance offered by the atmosphere, in the order of their magnitude.

Meteors are not incandescent when they reach the ground, but are still too hot to handle. Sometimes the high temperature is limited to their surface, while within they are extraordinarily cold. The spectators of a meteoric fall at Dhurmsalla, India, on the 14th of July, 1860, eagerly broke up the stones, still burning hot on the outside, and were greatly surprised to find that it was impossible to handle the inside parts on account of their extreme coldness. A similar observation was made on the 16th of May, 1883, at Alfianello, near Brescia. This contrast between the central part, still retaining the intense cold of the planetary spaces, and the outside, which only a few moments before had been red-hot, may be easily understood when we reflect on the feebleness of the conducting powers of stony substances, and the very short time that they had been heated.

One effect of this heat persists, and is obvious at first sight as a general characteristic of meteorites, in the shape of a black crust, entirely covering them. It is not a millimetre thick, and is generally dead, but forms in some especially fusible types a glossy enamel. The same effect, of vitrification, is produced by lightning on rocks which are struck by it. The incandescence of which this is the effect, and which had been observed in the meteor flying in the distance, is the result of the extreme speed with which the body penetrates the atmosphere.

It is, unfortunately, very rarely possible to find the fragments projected by meteors; and it is only under quite exceptional circumstances, even in populous countries, that one is discovered among the clods and under the vegetation by which they are commonly concealed. The observer enjoys the illusion of supposing he sees them fall at no great distance from him; but he will hardly ever find one if he looks for it. Probably three quarters of them are swallowed up by the sea.

Supposing there are three meteoric showers a year in Europe—and this is the mean of what has been observed there—and that that part of the earth is not exceptionally favored by them, we have one hundred and eighty a year for the whole surface of the globe. But, as many of the showers are not perceived, we may safely triple the figure, or even suppose there are six hundred, and still underestimate the reality. We are dealing, therefore, with a daily phenomenon.

We do not know in what regions of space meteors originate, nor what courses they follow before they come within the sphere of the earth's attraction. They have been supposed to be ejections from volcanoes in the moon. If this were the case, they would have to be supposed to have been ejected by the eruption with velocity enough to pass the neutral point, or the point where a body is equally attracted

by the moon and the earth. That velocity should be at least 2,270 metres a second, or about five times that of a cannon-ball; if it were less, the mass would fall back to the moon. Another more probable supposition is that they come from a group of minute asteroids which revolve in the space between Mars and Jupiter, whose orbits cross those of the large planets, ours included, and are occasionally met by the earth in its course. There is nothing else, since the beautiful researches of Schiaparelli have connected the periodical swarms of shooting-stars with comets, to assure us that they do not come from still more distant parts of the sky, or even from without the solar system.

Shooting-stars come to us by millions at regular periods; and the number of those which are directed toward our globe in a single year is estimated at many milliards. They somewhat resemble meteorites in the abruptness of their appearance in our atmosphere and the excessive rapidity of their motion, but they differ from them in an important characteristic. None of them ever reach the ground. They appear to share in the properties of comets, from which they may have been dismembered and told off by perturbing actions; while meteorites seem to be related to the planets. The difference between them is like the difference between gases or vapors and solid bodies.

The meteors coming to our earth without, excepting as to their superficial vitrification, undergoing any change, we are able, by subjecting them to analysis, to derive from them some precise facts respecting the constitution of the bodies in space. The first fact, which comes out from hundreds of analyses, is, that they have not brought a single substance which is foreign to our globe. About twenty-two elements, all known to the chemistry of the earth, have been recognized as present in them. Among these, iron, silicon, magnesium, nickel, sulphur, phosphorus, and carbon, are the most important. While they are all clad externally in a common livery, meteorites, when examined in their fractured parts, along with traits of similarity, present considerable differences. They have been classified, according to their types, into four groups, according to the proportion of iron they contained. Those of the first group are composed almost wholly of iron, which is known as meteoric iron. It is always alloyed with nickel and a few other metals, and contains carbon free or in combination, as in steel, with frequently sulphuret and phosphuret of iron in scattered globules and grains. It is always recognizable by a single peculiarity in its structure. If we moisten a polished surface of it with an acid, we shall immediately observe the appearance of numerous straight lines, as fine and as true in their parallelism as if made with an engraver's tool, and crossing one another in a net-work of regular geometrical figures. These designs, called the figures of Widmanstaetten, after the first observer of them, result from the fact that the metal is not of homogeneous constitution. It is composed of two alloys of iron and nickel, in a crystalline condition, one of which, not

being affected by the acid, stands out in relief from the other, which is attacked by it. The meteorites of this group are called *holosiderites*, or all iron, in distinction from the others, which contain also stony matters. They are vastly more rare than those of the other groups. The stony substances of the other groups consist chiefly of silica in combination with magnesia and peroxide of iron, as peridote or pyroxene. If these silicates are in small proportion and thinly scattered through the iron, they are *syssiderites*; if it is the iron that is in relatively small proportion and appearing only in isolated grains, they are *sporadosiderites*. In other meteorites, comparatively few in number, no metallic iron can be perceived, and they are called *asiderites*. The most interesting specimens among them are remarked by their dull-black color, and a general appearance like that of peat or lignite. Besides stony matters, they contain carbon in combination with hydrogen and oxygen—a chemical quality which has led to their being examined for remains of organic beings. But no trace of anything of the kind has been discovered. They also have escaped all alteration by heat beyond the superficial glazing, and thus strengthen the evidence that their origin is exterior to our globe.

Among all the diversities presented by the specimens of more than four hundred meteoric showers, is the remarkable fact that meteorites which have fallen at the most distant epochs, and in countries most remote from one another, not only conform to the same type, but present so complete an identity that their respective fragments can not be distinguished even upon a close mineralogical examination. Nothing in the exterior form of meteorites is more striking than a general aspect indicating that they are parts of a broken body. When we compare hundreds or thousands of stones of the same fall, we find that they all present polyhedral forms like those of stones broken for a macadamized road, except that the angles are more or less rounded. Even meteoric iron exhibits this angular shape, showing that its malleability and extreme tenacity have not preserved it from a violent rupture. It seemed impossible that such an effect could be produced solely by the action of the air, especially in the upper regions where it is in an extremely rarefied condition. But light has been thrown upon the problem since the introduction of the new explosives, which illustrate, in their industrial applications, the prodigious force that gases are capable of exerting, even in small quantity, when they are suddenly animated by a considerable tension. The explosion of a kilogramme of dynamite will break up bars of steel which a pressure of a million kilogrammes would hardly crack. Similar conditions concur in the upper strata of the atmosphere, slight as their density may be, when a meteor moving with planetary velocity strikes upon them. The body compresses the air more rapidly than it can yield, and transmits an equivalent motion to its own molecules. Under these circumstances, in the successive detonations caused by an enforced rotation, iron and the

most tenacious bodies will fly into pieces, as if they were struck with a pile-driver.

There is another no less characteristic feature of the surface of meteorites which testifies to the violence of the mechanical action produced upon them by the atmospheric rebound, exhibited by rounded cavities resembling finger-marks. They appear in the stony meteors, but are particularly characteristic of the iron masses. These marks were at one time attributed to transient explosions taking place during the course of the meteor through the air; but experiment has shown that the same appearance is produced in bodies which are acted upon by an explosion of dynamite; in the grains of coarse powder that drop, half consumed, from the mouth of a cannon when it is fired, and upon the touch-hole of the cannon. They are all due to the same cause—to the erosive action of gas revolving rapidly and moving spirally and under high pressure against the projectiles, boring into them as if it were a gimlet. The mechanical action is accompanied and aided by a chemical action which is dependent upon the combustible nature of iron at high temperatures. Although these blister-holes are worked only on the face which is exposed to the direct pressure of the gas, meteorites present them on various sides, and sometimes over their whole surface. This arises from the rotatory character of the motion of the body which makes it present every side in succession to the front.

With these mechanical phenomena of meteorites is connected the coming to the earth of dusts of celestial origin. In examining these, we must first be careful to separate the earthly dusts, with which the air is more or less loaded, of every kind, natural and artificial, from volcanoes and from waste tracts of the earth's surface, mineral, vegetable, and animal. These are recognizable by careful examination; and, after they are all detected, there remain still other dusts, which incontestably come to us from regions foreign to our globe. The carbonaceous meteorites of Orgueil furnish us a very interesting prime document respecting them. These bodies are so friable that they are reduced to powder under the slightest pressure of the fingers, and they would probably have been pulverized in their course through the air if they had not been protected by their heat-formed crust. Further, when aëroliths of this species are moistened with a little water, they are completely disaggregated and reduced to extremely fine particles in consequence of the solution of the alkaline salts which perform to them the part of a cement. Under this property, if it had been raining when the Orgueil meteorites fell, on the 14th of May, 1864, or if they had had to pass through a stratum of cloud, they would have been dissolved in their course, and all we should have found of them would have been a little black slime on the ground.

Extra-terrestrial dusts usually reach us under quite different circumstances, and without the intervention of water. The meteoric

stones as they pass through the air are followed by a tail which, at first bright, soon blends itself with the darkness, like the smoke of a piece of fire-works. It keeps the direction of the path of the meteor for a longer or shorter time, and is undoubtedly composed of particles which have become detached from the body, and remain suspended in the atmosphere till they are scattered by the winds. The mode of the action by which this dust is rubbed or blown off is explained by the experiments I have made with explosive gases in the investigation of the origin of the blister-holes of meteorites. Masses of gas at enormous pressures almost instantaneously pulverize whatever bodies they strike, and this is precisely what happens to the meteoric stones as they pass through the air. Judging from the thickness of the clouds following the bodies and the space they occupy, we conclude that they furnish considerable quantities of metallic and rock-dusts to our atmosphere.

A careful investigation of the dusts which may be supposed to be of cosmic origin is very desirable, as also is a systematic examination of the atmosphere by all the means in our possession, after every explosion of a meteor, for that which they may have left. Something has been done in this direction by Mr. Phipson, M. Nordenskiöld, and M. Gaston Tissandier. Doubtless the shooting-stars, extreme as their tenuity may be, also bring down ponderable substances in minutely divided condition. The spectroscopic examination of these asteroids by Mr. Alexander Herschel has revealed the presence in them of sodium, magnesium, carbon, and other bodies. The fact is confirmed by the formation, in connection with the extraordinary meteoric shower of the 27th of November last, of a cloud of vapors which obscured all the stars except those of the first three magnitudes, and was shortly afterward dissipated.

The question, whether gaseous and invisible substances may not also be introduced to the earth from the realms of space, can not yet be answered from observation.

The most interesting resemblances, and even identities, are occasionally revealed between the meteorites and some of the deeper rocks of our planet.

Volcanoes bring up daily, besides prodigious quantities of vapor of water and gaseous products, melted, intensely hot stony matters, which spread upon their flanks and are known as lavas. During the ancient periods, there came out also, from the depths below the granite, rocks of a nature very different from that of the stratified rocks, and presenting an analogy with the lavas. They occur on the surface in various forms of sheets, cones, and irregular masses. Below it, they constitute, in the thickness of the incasing rocks, a kind of columns, which are connected with the extremely deep reservoirs from which they have been thrown up; they have in fact been thrust here and there in consequence of eruptions, through the superposed masses, far

from their original bed. Like the lavas, they are composed chiefly of silicates.

We observe, in the first place, that most of the eruptive rocks differ considerably from meteorites. The most important point of contrast is that the latter contain nothing resembling the arenaceous or fossiliferous matters of which the stratified beds are constituted—that is, nothing suggesting the action and movement of an ocean or the presence of life. A great difference also appears in comparison with the masses on which the sedimentary beds immediately rest. Thus, we never find granite, or any of the minerals associated in it, in meteorites. The analogies of meteorites must be sought in the silicate rocks, which originate in deep regions, below the granite.

A striking example of this similitude is afforded by the recent lavas, which are formed from the association of two silicates, pyroxene and anorthite feldspar, and which correspond exactly with the meteorite picked up at Jonzac (Charente-Inférieure) on the 15th of June, 1819, and with that one which fell at Juvinas, in the department of Ardèche, on the 13th of June, 1821. Peridote, which is remarkably constant in meteorites, also occurs in the eruptive masses, often abundantly.

An equally remarkable fact is the absence from meteorites of the whole series of rocks which form an important part of the crust of the globe. It may be explained by supposing that the meteoric stones that reach us come exclusively from the internal parts of planetary bodies constituted as our globe is, or that those bodies are destitute of quartziferous silicates, like granite, as well as of the stratified beds. In the latter case, those stars have suffered less complete revolutions than our planet, and exhibit no traces of the co-operation of an ocean by which most of the crust of the earth above the internal masses has received its shaping.

A recent unexpected discovery, made by M. Nordenskiöld in Greenland, has shown the resemblances we have just described to be closer and more complete. It is worthy of remark that, notwithstanding the abundance with which iron is diffused in all parts of the crust of the earth, that metal has never been found in the native state. However pure and rich may be the mineral, some kind of a process is necessary to extract the metal contained in it. This peculiarity is due to the sensitiveness of iron in the presence of chemical agents, particularly of oxygen. Sir John Ross brought back from his arctic voyage, in 1818, some knives with blades formed of pieces of iron which the Esquimaux said came from scattered blocks not far from Cape York. The analysis of this iron showing the presence of nickel, a meteoric origin was attributed to it. Other samples of iron, offering similar characteristics, were brought down from the North by other explorers. M. Nordenskiöld's attention was attracted to some of these specimens, which had been deposited in the museum at Copenhagan, and prompted

him to endeavor to ascertain their origin during his voyage to Northern Greenland in 1870. After much searching, with the aid of what directions the natives could give him, he at last found the object of his investigations in the hill of Blaafjeld, or Ovifak, near Disco Island. Blocks of iron were lying on the shore at the foot of a high cliff composed of basalt and conglomerates of the same rock in alternation ; and more than twenty masses, containing not less than twenty-one thousand kilogrammes of metallic iron, were collected within a small space. They were at first supposed to be of meteoric origin, because they contained nickel, and exhibited figures which had been regarded as peculiar to meteoric iron. But this view was proved to be incorrect when M. Steenstrup, under a commission from the Danish Government to investigate the conditions under which the iron occurred, found, at one point on the coast, native iron actually imbedded in the basaltic rocks, the appearance of the larger grains of which was precisely similar to that of the scattered blocks previously found. The presence, in the eruptive rocks of the earth, of iron alloyed with nickel, similar to meteoric iron, and having the crystalline texture which had previously appeared to be an exclusive characteristic of the latter, has therefore become incontestable. It is proper to add that the metal in this condition is not a fortuitous and isolated accident in Greenland, but that it is found in many places and over considerable districts.

The geological structure of the northern part of that country is especially distinguished by the development of eruptive rocks of a relatively very recent age. It is one of the largest masses of basalt with which we are acquainted. It begins at the sixty-ninth degree of latitude, and disappears near the seventy-sixth degree, under the vast continental glacier which prevents all further exploration of the surface. It is reasonable to suppose that the eruptions of which these rocks are the result brought up metallic iron, of which they seem to indicate the existence of large masses in the deep interior. This fact has also to be taken account of in the theory of terrestrial magnetism.

After having sketched, twenty years ago, the numerous features of resemblance between the meteorites and the deep terrestrial rocks, and having shown how some of them can be imitated by a partial deoxidation of those rocks, I added : "There is nothing to prove that beneath those aluminiferous masses which have furnished, in Iceland, for example, lavas analogous to the meteorites of Juvinas, that beneath our peridotic rocks which the meteorite of Chassigny closely resembles, there may not be found masses in which native iron begins to appear, or resembling meteorites of the common type ; then, below these, types richer and richer in iron, of which the meteorites offer a series of increasing density, from those in which iron represents nearly half the weight of the rock to massive iron." Five years after these lines were written, the great masses of native iron alloyed with nickel,

of which we have just spoken, were discovered by M. Nordenskiöld. The discussions upon their origin, which we hesitated at first to regard as terrestrial, sufficed to bring out the close analogies between them and the meteorites. The study of the latter bodies has, then, permitted us to penetrate by induction into the internal constitution of our globe, as if by a side-look into depths wholly inaccessible to direct observation. The last demarkation has thus been effaced, and a most intimate connection has been established between the masses thrown up from the interior of our planet and the celestial masses of which the meteorites bring us the fragments.

The analogies which we have pointed out between meteorites and the profound regions of our globe testify to the identity of the chemical actions, even in the formation of stars very distant from each other. In fact, a mineral generally suggests, in a precise manner, the circumstances under which it originated. We might say that in itself it tells the story of its origin, especially when it can be reproduced experimentally. We thus perceive how reason, assisted by experiment, can give us clews to the formation of the stars of which we possess fragments. Silica or silicic acid is a chemical agent, the energy of which becomes very considerable at high temperatures; it is also the characteristic element of numerous products formed in industrial furnaces, like glass, scoriæ, and slags, and of the lavas of volcanoes. All the silicates, artificial and natural, when free from water, or in the anhydrous state, denote the dominance of a high temperature over their formation.

Suppose that silicon and the metals were not originally combined with oxygen as they are now, either because the different elements were not near enough together in the primordial chaos, or their temperature was not high enough to permit them to enter into combination. When oxygen comes into action, it unites at first with the elements for which it has a predominant affinity, primarily silicon and magnesium, then iron and nickel; and, if the gas is not in excess, it leaves a residue composed of the less oxidable bodies. Iron and nickel would in that case be left in a free state, disseminated among the stony silicates. This is exactly what is observed in the meteorites; and it is also a fact which I have confirmed by experiment. By producing the conditions that have just been mentioned, I obtained an imitation in essential points of meteorites of the common type, with the production of a silicate of magnesia and protoxide of iron, having exactly the constitution of peridote.

Furthermore, one of the best-known every-day metallurgical operations, the decarbonization of cast-iron, or its transformation into malleable iron or steel, gives an analogous reaction and ends in a result of the same kind. Whether the process be carried on in little charcoal-furnaces, as in antiquity, or in puddling-furnaces, or, as by the Bessemer process, without the addition of any combustible, it is always the

oxygen of the air which burns, not only the charcoal, but also the silicon in the pig and a part of the iron. The black scoria which is formed in the process often contains a peridote with a base of iron, having the same chemical constitution and crystalline form as the magnesian peridote of the eruptive rocks of the earth and of the meteorites.

The simple oxidation of silicon develops an enormous quantity of heat, very much more than the combustion of carbon; a heat which is sufficient to refine the metal in the retorts of iron and steel works without the addition of carbon. Silicon, which in nature has passed wholly into the state of silicic acid, or been burned, must, at the moment of its combination with oxygen, have been the cause of an intense heating both in our own globe and in the other stars, which are also composed of silicates. But in the last, of which meteorites are the fragments, the temperature was not probably so high as in the metallurgical furnaces and the experiments we have cited. It is, in fact, very remarkable that, notwithstanding their tendency to a distinct crystallization, the silicate compounds of which the meteorites are constituted are only in the condition of very small and quite confused crystals, as if they had not passed through fusion. We might say that, rather than the long needles of ice which liquid water forms in freezing, their fine-grained texture resembles that of frost and snow, which is known to be due to the immediate passage of atmospheric aqueous vapor to the solid state.

In brief, the extreme tendency of the oxidation of silicon to produce the formation of peridote, daily proved in our laboratories and shops, is no less evidently manifested in the deeper rocks of our globe, on the one side, and in the distant stars from which the meteorites come, on the other side. Everywhere are observed the effects of an ancient and vast oxidation. In this we have a simple and experimental explanation of the ubiquity of peridote. It is the universal scoria.

As a forest shows at a glance the plant-life of all ages, the universe presents us stars in all the phases of their existence, from that of incandescent heat to obscurity, and an advanced cooling. We have also just seen that some of them are in demolition, and that their fragments fall upon others, to which they remain attached. The numerous falls of meteorites on our globe teach us that this fact, instead of being an exception, answers to an habitual *régime*. And the constitution of the meteoric masses teaches us with certainty that the celestial bodies whence they emanate have a chemical history quite similar to that of the interior regions of our planet.

So, while the exploration of the sky reveals to us millions of worlds beyond our solar system, our planet, small as it is, offers us an example of the changes which the stars have undergone, and an episode in the general history of the universe. The meteorites form a kind of line of union between the succession of the epochs of the earth, the object

of geological study, and the constitution of the sky, the aim of astronomical research. These two parts of human knowledge reflect complementary lights upon one another.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

THE CARE OF THE BRAIN.

By Professor AMBROSE L. RANNEY, M. D.

THERE is a natural tendency on the part of most parents to aim at precocity in their first child. They love to boast of its progress, and to draw favorable comparisons between it and the children of friends. Sometimes, as we all know, they overdo the matter, and produce a mental deformity, or a mental dwarf, or an idiot, or a grave in which their hopes as well as their error are buried.

No question is more difficult for a parent to decide than this: "When and how shall I begin to train the mind of my child?"

Unfortunately, the advice of teachers or physicians upon this topic is not always the same. Some answer such a question hastily; some from preconceived opinions that are not always free from bias. Others, again, fail to investigate, before answering, the hereditary tendencies of the child, whose future they are called upon to be instrumental in molding. Finally, most teachers and some of the medical fraternity are more or less ignorant themselves of the later discoveries made in cerebral physiology, and are therefore not always well fitted to be advisers respecting the best means to develop the organ of the mind properly.

The human brain is more wonderful and delicate in its construction than any invention of man. Few of those who have children seem to appreciate the care that should properly be exercised in promoting its natural growth and the best development of that organ—especially during the early years of life.

Parents who watch with anxiety against the possibility of bodily deformities in their children are often unaware of the harm that may be done to young brains by ignorance or neglect on the part of those who have them in charge. They know nothing themselves of the organ of the mind, but they think themselves justified in believing that a system of training which has produced good results in some children is applicable to each and every one.

Now, it should be remembered that minds, like faces, are not cast by Nature in the same mold. The quality of workmanship and the material is finer, so to speak, in some brains than in others. Some children are congenitally predisposed to nervous excitability or debility. Certain of the component parts of the brain become perfected during their development before others. Some of these parts are capable of

acquirement from the moment of birth, while others are not called into play for many months afterward.

I have known many a child to be crowded prematurely to a point in mental development that has either arrested further growth of the intellectual faculties or caused its death indirectly.

Hardly a month passes in which I am not compelled to urge parents (often against their inclinations) to modify or discontinue some defective system of mental training of their children. Many cases of idiocy, epilepsy, St. Vitus's dance, dropsy of the brain, and other nervous diseases of childhood encountered by physicians, might have been prevented if the parents had been made intelligent respecting the dangers that encompassed the child, and used proper precautions against them.

Within the past decade, the functions of different parts of the brain have been determined with an approach to scientific precision. We are now able to trace (by methods lately discovered) the course and terminations of separate nerve-bundles which compose the bulk of the brain. Pathology has helped us to verify, in the case of man, the deductions drawn from experiments upon the brains of animals. The microscope has enabled us, furthermore, to detect structural differences between various groups of brain-cells, whose functions have been shown to be totally distinct from each other.

These and other discoveries (too numerous to mention here) have a practical value as well as a scientific one. They afford us many hints which may be applied during life. They aid us materially also in preventing as well as relieving diseased conditions of the wonderfully constructed mechanism.

These are the few physiological facts which I am particularly desirous of impressing upon the reader, since they form a basis for my conclusions. These may be summarized as follows :*

1. Different areas of the surface of the brain have functions *peculiarly and exclusively their own.* Thus the brain's surface may be likened to a map with its various territories, each of which is at times perfectly independent of the other in respect to its functions, but still capable of concerted action with the rest when such action is required. We recognize as distinctly defined those areas, for example, which preside over motions, sight, smell, taste, touch, hearing, general sensibility, and some others.

2. Each of these areas of the brain-surface has to be *separately educated.* The memories connected with past experiences are stored within the cells of the area which appreciates the facts as they occur.

3. Some parts of the brain *develop more rapidly than others.*

4. The education of some parts of the organ consists chiefly of the

* There are certain anatomical and physiological facts respecting the human brain to which the attention of the reader could be directed with benefit before the practical part of this subject is discussed. To those who are interested in this field, I would refer

acquisition of memories of such things as the part in question has been specially designed to appreciate. This is particularly true of the parts related to vision, hearing, smell, taste, touch, etc.

5. The *higher mental faculties*, such as judgment, reason, self-control, etc., require the *concerted action of different parts* of the brain's surface. This is because all such acts are based, of necessity, upon our recollections of past events. These recollections may have been acquired by the aid of sight, hearing, general sensibility, smell, etc.

6. The cells of different areas of the brain do not exhibit in individuals the *same aptitude for the acquisition of knowledge*—some people remembering most easily what they see, others what they hear, others what they handle, etc.

7. In case some parts are deprived of their functions, other parts are *rendered vicariously more active*. We see this illustrated in the extreme sensitiveness of the ear and touch in the blind.

8. *Prolonged disease of any part of the brain* may cause a wasting-process (atrophy) within the brain-cells of that part.

With these deductions as a basis, we are prepared to discuss intelligently what may be regarded, in the light of existing science, as our guides toward promoting the best welfare and growth of this important organ. The views which I shall advance here are based upon the physiological facts enumerated. These have been satisfactorily demonstrated within the past decade.

In the first place, I would raise my voice in strong protest against the popular fallacy that every child, who presents no apparent deformity of limb or evidence of physical or mental weakness, "should be sent to school early to keep it out of mischief."

During the period of early childhood (from four to seven years of age) most of the knowledge gained by the brain is acquired chiefly, if not exclusively, through the organs of sight, of hearing, and of touch. The brain is thus kept in a state of healthy activity—receiving all manner of impressions, and storing up memories of what is consciously imparted to it. Of the special senses, sight is by far the most important to the child, because it is the most used.

Now, congenital and acquired *deformities of the eye* are not infrequent. They are among the most common of malformations—although too often unrecognized. Very often a serious defect of vision in a child is not suspected by its parents.* Again, the fact is frequently dismissed, even when the existence of such a defect is known, with the remark that "glasses are a disfigurement to a child, and that any child is better off without them than with them." I have been pained

them to an article contributed by myself to "Harper's Monthly Magazine," April, 1885, and to the popular work of Luys upon the "Human Brain," D. Appleton & Co.

* Far-sighted subjects have remarkably acute vision in spite of the fact that the eyes are too shallow. They see entirely by the aid of *muscular effort*, and sooner or later suffer from the effects of "eye-strain" unless the proper glasses are worn.

many times to hear medical men of intelligence support such a statement, and to urge their patients to avoid glasses as long as possible, in order that they might not become dependent upon them. To those who hold that idea, I would simply say that if they will read the article written by Dr. Loring upon this subject ("Harper's Monthly," August, 1879), and one by myself on a somewhat similar field ("New York Medical Journal," February, 1886), they will be convinced of their error and the sad results that may occur from such ignorance.

I earnestly advise, therefore, every parent to consult some expert (not an optician), before sending a child to school, and thus to ascertain if the organs of sight be anatomically perfect. If they are not so, the health and mental vigor of the child are liable to be slowly undermined.

I have seen serious damage done both to the health and mind of a child by the neglect on the part of parents to remedy an optical defect early by glasses. Many evil results may arise from the neglect of this simple precaution. Children very often become cross-eyed—the laughing-stock of their playmates—in consequence of an optical defect that has not been corrected early. Again, they frequently develop habits of idleness and incur the censure of their instructors on account of some optical defect, because their eyes cause them an indescribable sense of weariness when study is attempted, which a child is unable to withstand. I have encountered many adults who have struggled on to manhood with an ocular defect of which they were unconscious—suffering excruciating headache and many other symptoms of nervous derangement. When glasses brought relief at last, they have experienced an unknown sense of delight in reading and mental effort. I recall an instance of this character where a patient of mine would frequently rub a blistering lotion into the hair to relieve a headache that was almost incessant, and unfitted him for mental or physical labor. Glasses brought about a cure that was to him miraculous. The eyes of a child are fortunately more pliable and elastic, if we may use such an expression, than of an adult; hence some optical defects may be compensated for by muscular effort for years, although always with detriment to the physical vigor.

It is a difficult matter in many instances to make laymen, and even those of the medical profession who have given this matter little attention, appreciate the difference between "seeing without effort" and "seeing with eye-strain." The perfectly constructed eye should bring the images of all objects removed from it beyond the twenty-foot limit to a focus exactly upon the retina *without any effort on its own part.* It should be able to afford distinct vision of distant objects while passive; and thus rest itself from the fatigue of focusing objects within a circle of twenty feet radius. The far-sighted eye knows no such repose during the wakeful hours. Although the vision is very acute in most far-sighted children and in spite of the fact that

they are unconscious often of the strain produced by the unceasing muscular efforts required to see with distinctness, this condition of the eye tends (when not corrected by glasses) to weaken the nervous energies and produces in some cases the most distressing nervous symptoms. The far-sighted eye is particularly liable to be left without correction because its existence is often unsuspected.

2. I would suggest that the parents or guardian of a child, that has hereditary predisposition to debility or disease, should consult some intelligent physician respecting the advisability of sending such a child to school. Advice can then be had in regard to the studies which the child should pursue, and the daily amount of mental effort which it may safely attempt.

Some children are better able to apply themselves to study at five years of age than others are at ten. Irrespective of the fact that some of the brightest men of all epochs have shown remarkable precocity at a very early age and have been subjected to mental discipline when very young, I deem it wise to caution parents against an experiment that may prove disastrous to the future welfare of their offspring.

3. I would urge every parent, as a precautionary measure against disease of the brain, to avoid (from birth to the age of seven) all romps or other form of excitement immediately before the child is put to bed. Such excitement tends to prevent healthy sleep. It may thus precipitate the development of some nervous trouble in the child, by depriving the brain of its proper rest. Too much stress can not be laid upon this point. The error referred to is one that is thoughtlessly committed by thousands of parents.

4. Every child should get at least ten hours of good sleep each night. The old saying that "one hour's sleep before midnight is worth two after" is not to be disregarded. A child between the years of two and seven should be in bed and asleep by 6 P. M. every day.

5. The sleeping-rooms occupied by children should be large and well ventilated. They should be lighted by the direct rays of the sun, and have large windows. It is far better to give up the best room in the house, if necessary, in order to insure the health of your children, than to reserve it as a parlor for the entertainment of guests.

6. Children should eat at a separate table from their parents until ten years old at least. They should take their hearty meal at midday. It is not conducive to the proper development of any child to be surrounded constantly with food of which they should not partake; nor is it wise to load the stomach with food before retiring.

7. If you wish to keep children free from disease, avoid all pastries and sweets, as far as possible, and confine them to simple and nutritious food. The habit of feeding candy to children between meals, or of allowing them to eat at irregular intervals, is to be strongly condemned.

The nervous system is particularly affected by gastric and intesti-

nal derangements during childhood. This is also the case with adults, but to a smaller degree. Convulsions in children are often the direct result of improper feeding. I recall a case of an adult whom I once was called upon to treat, where an epileptic fit would invariably occur whenever he ate of banana. Stopping that fruit (of which he was very fond) cured the attacks.

8. Insure exercise for your children in the open air during all seasons of the year. Cold or inclement weather should not hurt a child if properly dressed for it. Avoid chilling the surface of the body or the contact of damp clothing to the skin, as far as possible, especially if the child has a hereditary predisposition to tuberculosis or scrofula. Even during infancy, I believe in the inhalation of fresh air for at least two hours daily, untainted by the gases of furnaces, gas-light, imperfect sewerage, etc., in which most city houses abound.

An open fire in the nursery tends to purify the air during the winter months, when the windows are kept closed ; and prevents overheating of the room. The temperature of a nursery should never be allowed to exceed 70°, and should be as nearly uniform as it is possible to keep it.

Children with scrofulous tendencies or a hereditary predisposition to tuberculosis should be reared in the country, if possible, until they have passed the seventh year. This tends, in many cases, to prevent the development of hydrocephalus and epilepsy, to which such children are strongly predisposed.

9. Avoid in the case of children all books of a particularly exciting character.

This suggestion applies with great force to those who display a tendency to nervous affections, or who inherit a decided predisposition thereto. The paper-covered novels for boys, so extensively sold to-day, in which murder, rapine, and hair-breadth escapes are frequent, are very pernicious to the young.

Try and cultivate in your children a love for that which will both instruct and amuse them. Near-sighted children always prefer books and in-door amusements to out-of-door sports ; hence they are usually spoken of by their parents and friends as precocious beyond their years. This is a mistake. Glasses will remedy the evil, and enable such children to enjoy romping games, etc., which imperfect vision had previously rendered impossible or unattractive.

10. Teach your children, even when young, to develop their memories. Do this by all possible methods, except the committal of prose or poetry in excess. Nothing pains me so much as to hear a very young child recite long pieces from memory, which could have been acquired only by protracted study. Such feats of memory may be followed by injurious results to the brain. It is said that a famous conjurer was accustomed to test his boy's perceptive memories by asking him to recall all he saw at a passing glance when walking by shop-

windows. In this way the boy was soon able to grasp, by his organs of sight, many details of objects that had previously escaped him.

The eyes are our most valuable organs. They afford food for thought, and give us one half of our information at least directly. If they are anatomically perfect, they can be used to perceive objects at a distance of more than twenty feet as perfectly as within that radius. Near-sighted persons can not do this, because objects of moderate size have to be brought closer to the eyes than twenty feet before their details are apparent. In many of our modern school-rooms the blackboard is more than that distance from the farthest row of seats; hence a near-sighted child can not see blackboard explanations well, and a far-sighted child is subjected often to an excessive and unnatural strain of the eyes in its attempts to follow them. Such exercises form a prominent feature in our present methods of teaching. It is an easy matter to teach children to dexterously use their eyes, as well as their ears and fingers, and to remember the details of all they see, hear, and handle, if the parents or instructors will use a little tact in that direction.

11. Encourage athletics in children, even at the expense of some mental progress, until the body is well developed. Healthy bodies tend to keep the mind vigorous and to prevent nervous derangements. Habits of exercise acquired during childhood tend to promote a love for athletics in the adult, which often helps to counteract the bad effects of anxiety and mental fatigue. Horseback-riding, hunting, fishing, base-ball, tennis, and other out-of-door sports, are important aids to longevity.

12. Respecting the education of children, I believe that object-teaching should be first employed, and continued until the child exhibits all the evidences of physical and mental vigor. It is time enough to begin systematic instruction when the brain is well stocked with memories of all kinds, and when the perceptive faculties have been made acute by careful discipline. Many a child has taught itself to read by playing with blocks upon which animals and other objects are printed above the letters that spell their names.

When the study of books is deemed advisable, let it be done in a well-lighted and thoroughly aired school-room, and not at home in the evening by artificial light. When the body is fatigued by play and the routine of the school during the day, it is contrary to common sense to weary the brain still more by urging a child to mental effort when the light is poor and the body needs rest. If a child must study at home, let it be done in the early morning hours, after a light repast on rising from the bed.

To my mind, the natural talents of each child should be allowed free scope for development. It is absolute folly to dwarf the brighter parts of a young intellect by a fruitless endeavor on the part of the parents or teacher to bring out some talent for which the child has

little or no aptitude. All minds can not be compressed into an identical mold without doing serious injury to some individual brains. A child with keen perceptive faculties and good reasoning powers is capable of growth in some directions, much more rapidly and with far greater pleasure to itself than in others.

Finally, I would suggest that parents study with care and anxiety the mental and physical traits of their offspring. Allow neither to detract from the other. Pick out for each child the line of development for which Nature seems to have furnished the best material, and the result will conduce to the future success of the child and the ultimate happiness of the parents.

RUSTLESS IRON.

By JAMES S. C. WELLS, Ph. D.

Of the many methods in use for the protection of iron from rust, the one of most scientific interest is the so-called Bower-Barff process. By this treatment the iron is coated with a layer of the black or magnetic oxide of iron (Fe_3O_4), and, as is well known, this oxide does not undergo any further oxidation on exposure to air or water—proved by the magnetic iron-ores and sands, which withstand any amount of weathering. The liability of iron to rust is a great drawback to its use for many purposes, and the practical value of a process which will protect it, at a slight expense, is self-evident. That the process is successful in accomplishing this object seems no longer a matter of doubt, and at less cost than galvanizing or tinning. The color on cast and wrought iron is a bluish-gray, which to some may be objectionable, but, as the coating takes paint far better than untreated iron, this objection is easily overcome, and with the assurance that the paint will remain, and not soon be thrown off as it is generally. For polished work the color is a lustrous blue-black, adding greatly to the beauty of the article treated. This process seems peculiarly well adapted for gas and water pipes. Any one who has had occasion to use water which has passed through a new iron pipe, or one that has not been used for some time, knows how full of rust it is, and that only after months of constant use does it become clear again. With pipe coated with the magnetic oxide by the Bower-Barff process, no trouble of the kind can occur. The water runs pure from the first day, and if for any reason the pipes are emptied, and left so, there is no danger of their becoming coated with rust. Another important fact is, that the water coming through one of these rustless pipes is just as pure as when it entered, for the water can dissolve none of the coating of oxide, as it always does with lead or galvanized pipes. It is a well-known fact that water running through lead pipes is very apt to

contain lead in solution, and the continued use of such water causes lead-poisoning, for, although the amount (of lead) dissolved may be very small, still it accumulates in the system, and finally causes sickness and disease.

Professor Venable has lately shown that water passed through galvanized pipe dissolves quite an appreciable quantity of the zinc coating, thus making it unfit for drinking purposes. Tin-lined pipes are also used, and until the introduction of the "rustless" pipe were considered the best, but were far from being all that could be desired; in many instances, after using for a time, the coating was completely destroyed. Then, again, if the pipe is to be better than lead, the tin used for the lining must be pure, because if it contains lead, which is often mixed with tin, it would be worse than the common lead pipe, the alloy dissolving much more readily than either would alone. Considerable architectural iron-work protected by the rustless process is being used with very satisfactory results. It is needless to multiply examples of its usefulness, for numberless ones will occur to the reader. Up to the present time only four furnaces have been built in this country—two in Brooklyn, one at Little Ferry, New Jersey, and one in Philadelphia. The processes by which this coating of magnetic oxide is formed differ accordingly as the iron is cast, wrought, or polished. The Bower process is the better for cast-iron, and consists in oxidizing it by means of carbonic acid and air. In the Barff method, which is the one used for wrought-iron and polished work, the oxidation is produced by means of superheated steam. This method will also give a coating of the magnetic oxide on cast-iron, but the action is very much slower than with the Bower treatment, and consequently more costly. The difference is probably due to the large amount of carbon contained in cast-iron, and which has to be oxidized as well as the iron, i. e., the carbon contained in the film of iron which is changed to oxide. It may be asked then, why, if air does the work so much quicker than steam, it can not be used for wrought-iron and polished work, as well as for cast-iron? It has been found by experience that the coating produced on the former, when air is used, is liable to scale off, which is not the case when it is treated with steam. Cast-iron after treatment seems tougher than before. I have frequently noticed, when present at the unloading of a charge of hollow-ware that had been treated, a kettle or pot fall off, and, although falling against heavy iron, it would bound off and reach the floor uninjured. The same accident happening to any such article before treatment is almost sure to break it. Whether this toughening is caused by a kind of annealing due to the slow cooling of the charge after coming out of the furnace, or whether it is that the surface of the iron becomes malleable owing to the oxidation of its contained carbon, I can not say, but think it probable that both contribute to the result. Mr. Bower, in his first experiments, treated the articles in a muffle-furnace—that is, a furnace

in which only the oxidizing gas, either air or carbonic acid, was allowed to come in contact with the iron ; but this was found to be costly as well as unnecessary. Now the furnaces are built so that the products of combustion of the coal, used to heat the furnace, come directly in contact with the iron undergoing treatment, and by a suitable arrangement of dampers, etc., the same furnace can be used for the Barff or steam process. In his experiments the inventor found that, if he admitted a large excess of air, the article came out covered with the red oxide of iron (Fe_2O_3), and that below this red coating was a thin film of the magnetic oxide. For some time he was at a loss how to regulate the quantity of air added, so as to prevent the formation of this red oxide, but finally hit upon the following plan : During a certain time the iron was oxidized in excess, that is, to sesquioxide (Fe_2O_3), and then it was subjected to a reducing action for a definite shorter period. In this way it was obtained covered with the magnetic oxide only. The chemical reactions that take place are given by Mr. Bower as follows : the excess of air during the first part of the reaction causes the formation of sesquioxide of iron (Fe_2O_3),

$$2\,Fe + O_3 = Fe_2O_3\,;$$

but, this being in contact with red-hot iron, its lower surface is reduced to magnetic oxide, as shown in the following reaction :

$$4\,Fe_2O_3 + Fe = 3\,Fe_3O_4.$$

It would seem from this reaction that no reduction period would be necessary : theoretically it would not, but practically it is required, as there is always an excess of the red oxide (Fe_2O_3).

This excess of the red oxide is then reduced to magnetic oxide by the reducing gases, consisting chiefly of carbonic oxide (CO), which is converted into carbonic acid as follows :

$$3\,Fe_2O_3 + CO = 2\,Fe_3O_4 + CO_2.$$

When steam is used instead of air, the steam coming in contact with red-hot iron is decomposed, giving up its oxygen to the iron, and forming the black oxide, its hydrogen being at the same time set free as gas. The following shows the reaction :

$$3\,Fe + 4\,H_2O = Fe_3O_4 + H_8.$$

We will now pass to a description of the different processes, as carried out on the large scale. The furnaces in use vary somewhat in construction, but the principle is the same in all. The iron to be treated is placed in a large fire-brick chamber, known as the oxidizing chamber, into which the gases from the producers pass after having been through a combustion-chamber. In the latter the gases can be mixed with air, and burned, when necessary, the amount of air being regulated as required. The producers are simply very deep fireplaces, the bed of coal being three to four feet deep, so arranged that only sufficient air is admitted to burn the coal partially ; that is, instead of being converted into carbonic acid (CO_2), it is only allowed to take up one atom of oxygen, and thus forms carbonic oxide (CO). The latter,

either alone or mixed with hydrocarbons, formed by the decomposition of naphtha, used during the reduction periods, is the gas that passes into the combustion-chamber to be there mixed with air or not, according to the result desired to be produced.

The fuel used in this country is anthracite coal, with the addition, during the reduction periods, of a little naphtha or crude petroleum. A small stream of the oil is led into the top of one of the gas-producers, where it is vaporized, and passes along with the other gases on their way to the oxidizing chamber.

Cast-iron before it can be treated requires to be "pickled," to remove any sand adhering to the casting. The "pickling" is done as follows: The iron is first placed in a bath of dilute sulphuric acid, and allowed to remain there for from ten to fifteen minutes, or even longer, if the casting is a very rough one. It is then removed and washed with boiling water, and when dry the sand which is now loosened is taken off with steel brushes. Now the article is ready for treatment in the furnace. The pieces to be treated are placed on the drag, a heavy iron plate, which is run into the furnace through a large door in one end. Before making the charge, the furnace must be heated to a white heat; having attained this temperature, the door is opened and the charge run in as quickly as possible, then closed and tightly luted, so as to exclude all air. The charge is heated with a slightly reducing flame, that is, one in which there is an excess of carbon, until it has reached a bright cherry red. During this heating of the charge only enough air is admitted to the combustion-chamber to partially burn the gases. When it has reached the proper temperature, the "gas" is turned on, that is, the supply of air is entirely cut off, a small stream of oil is allowed to flow into the producer, and the chimney-damper nearly closed. The flame in the furnace now becomes smoky. During this reduction or "gas" period, which usually lasts twenty minutes, the gases rich in carbon come in contact with the red-hot charge, and reduce any sesquioxide to magnetic oxide. At the end of this time the oil is shut off, the gas partially so, and the chimney-damper opened. When the furnace has become free from smoke, the air-valve is opened so as to let air enter the combustion-chamber in quantity only slightly in excess of that needed to burn the gases completely. This excess (of air), in conjunction probably with the carbonic acid formed by the combustion of the gases, oxidizes the iron to sesquioxide, which will be reduced by the next "gas" to magnetic oxide. When the oxidizing period, which lasts forty minutes, is over, the air-valve is closed, the gas turned full on, and the oil run into the producer as before, and the second "gas" or reduction period of twenty minutes begins. These alternate periods of reduction and oxidation are continued for from eight to ten hours, and the charge is drawn at the end of the last "gas," or, what seems to assure better results is, instead of withdrawing the charge now, to complete the treatment by admitting steam for

one hour, as in the Barff process, to be presently described. By thus finishing the operation with steam a more uniform color is obtained, due probably to the oxidation of any protoxide of iron that might possibly have been produced during the last reduction, thus insuring a coating consisting only of magnetic oxide. Wrought-iron or steel, of course, requires no "pickling," as there is no sand to be removed. The furnace is heated to the same temperature as for cast-iron, and then the charge is run in and heated up with a strongly reducing flame until it reaches a bright red. The "gas" is then turned on for twenty minutes, and, when this time has expired, the chimney-damper and gas-valve are both closed tightly, and the steam-valve is opened into the combustion-chamber. The steam, in passing through this chamber, which is at a white heat, becomes highly superheated before reaching the charge in the oxidizing chamber. It is known that sufficient steam is being admitted, by the amount condensed on a cold iron bar held at one of the openings, through which the excess of steam and the hydrogen set free in the reaction escape from the furnace. The steam is kept on for from eight to ten hours, and then the charge is withdrawn. When polished work is to be treated, the furnace is not heated so highly as for wrought-iron, and, just as soon as the charge has been made, the gas is turned on for one hour, then steam is admitted, and the operation goes on the same as for the latter, with this difference, that the temperature in the furnace is kept very low—so low, in fact, that on looking into the furnace the charge is scarcely visible. If too high a heat is used, it causes the coating to scale. The steam is kept on for from eight to ten hours, and the charge is taken out. At first the articles treated are completely covered with soot when they come out, and do not look attractive, but, on rubbing with oil, which is the next step, the soot is removed, and leaves the articles a beautiful, lustrous blue-black.

THE DEVELOPMENT OF MINERALS.

By M. J. THOULET,

OF THE SCIENTIFIC FACULTY OF NANCY.

IN a lecture on "The Life of Minerals," which was published about a year ago, I tried to bring out a few principles which seem to assert themselves as each day's work contributes new facts and suggests new thoughts in science, and which seem to give a general direction to the labors of investigators. These principles were, in brief, that all the laws relating to the mineral kingdom are also applicable to the vegetable kingdom, which is, besides, governed by other laws special to it ; all the laws of the vegetable kingdom are valid in the animal kingdom, and it has, besides, its own other special laws. One of the results of the progress of science has been gradually to

make less distinct the lines that separate the three kingdoms from one another, so that we are led to the conclusion that the mineral kingdom is connected by successive degrees with the vegetable and animal kingdoms, and consequently that matter is one.

Hence the study of mineralogy, giving the word its real signification of a science applying to all unorganized bodies, ought to precede the study of botany and zoölogy, because it is the rational introduction to knowledge respecting the phenomena of Nature. There is manifest in these days an evolution from the sciences called natural toward the physical and chemical sciences, and from the physical and chemical sciences toward the mathematical sciences.

A natural phenomenon is the resultant of multiple actions which make themselves perceived concurrently in its manifestation. It is an equation containing many unknown quantities. There is only one way to resolve it : it is to find a sufficient number of other equations containing the same unknown quantities with different coefficients and exponents, and then to eliminate the unknown elements one after the other. That is the object of experiments, in which man intervenes with his intelligence and his hands to simplify and finally to resolve the problem that he proposes to himself, which is to obtain a complete knowledge of the phenomenon. In every experiment he retains as constants some conditions which he can not wholly get rid of, and limits himself to putting a single variable through its changes. He then makes constant the variable, of which he has just examined the influence, and subjects to modifications one of the other variables which he had previously held as a constant. This work is really the same as to formulate a new equation between different unknown quantities. Every science must therefore rest upon experiment, which alone is capable of leading to the knowledge of the law—that is, to a generalization, and of permitting the student to foresee results. A science which can not generalize or foresee only deserves the name of simple knowledge. Detailed observation translated into minute description is the servant of experimentation, for its task is limited to verification.

The science of inorganic bodies, mineralogy and geology, has been the first to feel the effects of the evolution of the natural sciences toward the exact physical and chemical sciences. Its phenomena present the minimum of complication ; it ought, even more than the others, if that is possible, to be founded on experiment, measure, figures, and number.

I have been gratified to find my views on these subjects corroborated by the observations of Professor Mario Pilo, of the Lyceo Balbo in Turin, as recorded in a paper published by him in the "Rivista di filosofia scientifica," on "The Life of Crystals ; or, Outlines for a Future Mineral Biology." This author has collected a large number of results agreeing with the doctrine of the successive and insensible

passage from the stone to the animal; and, although I am not in absolute accord with him in all his conclusions, we agree in the most essential points.

These studies are not of yesterday, and, as is the case with many other branches of knowledge, it is hard to go back to the first person who entered upon them. No branch of science is born in a day; but they all come to their growth in the minds of men and of masses of men by a kind of infiltration, or slow and often unconscious accretion. In 1867 M. Bombicci, Professor of Mineralogy in the University of Bologna, became especially interested in phenomena relating to minerals. Some of his experiments in crystallography were of particular interest, and were marked with the stamp of a rare originality of conception. But he treated the problems they suggested with great boldness, and carried his speculations upon them, perhaps, beyond the limits of rigorous science. It fell to M. Pilo's lot not to institute new experiments, but to collect those of M. Bombicci, his master and friend, correct and edit them, prune them of what about them was too technical, and, checking them with new facts duly substantiated, to present them in a more modest aspect, better deserving to attract attention. M. Pilo has given, in a kind of list, the analogies between the organic and inorganic kingdoms, and has concluded from them that there exists a kind of mineral biology. His memoir, aside from its philosophical parts, is a comparative chart of organic biology and mineral biology, and shows that all the branches of studies relating to organic beings can also be applied to minerals.

He begins by defining life as the state of integration of matter when it, departing from the simply molecular condition, arrives at the state of forming complex groups of determined chemical and physical structure, and becomes capable of reacting upon the ambient medium in such a way as to assimilate to itself the elements peculiarly suitable to it. The individual being a determinate chemical compound under a determinate form, the elementary crystal presents all the characteristics of individuality, comprising of them, under the name of crystal, all that has been called, with certain differences of significance, the integrant molecule by Haüy, the physical molecule by Delafosse, or the elementary crystalline stitch of the crystalline network by Bravais. I do not think that, even admitting this definition, we have any right to deny individuality to bodies that are called amorphous. It is not becoming to adopt the exclusiveness of the old mineralogy, which assumed to occupy itself only with the minerals existing in the bosom of the earth, and regarded as of its domain salt when it was found in mines, but refused to study the chloride of sodium which was produced in a laboratory. Amorphousness is still only a condition of form, and it would be absurd to give individuality to a gramme of crystallized sulphur, and refuse it when the same gramme of sulphur, having been fused, has been cooled in a vessel of water. The word

amorphous simply means not crystallized. Furthermore, the crystalline condition is connected with the amorphous condition by an uninterrupted series of gradations, as has been proved by the labors of Vogelsang and Lehmann. The former of these observers dissolved sulphur in sulphuret of carbon, and thickened it by mixing with it Canada balsam, the viscosity of which caused a delay in the crystallization at the will of the experimenter. By this method he substantiated a grouping of the matter into globulites, or minute isolated spheres; then into margarites, or files of spheres joined to one another. He next produced trichites, which are abundant in the obsidians—a kind of extremely fine threads of mineral, containing an internal channel, and rolling up in the most irregular fashion; microliths, under the various forms of longulites or belonites; and, finally, the crystallites and crystalline skeletons of Lehmann; and these, in their turn, led to real crystals. Each of these states presents itself as a more perfected condition than the one that precedes it, as a new appearance and complication of physical properties. Why, then, abruptly break the chain, and, having recognized the passage from the animal to the plant, and from the plant to the crystal, deny the transition, otherwise very visible, from the crystal to the amorphous body, and pretend that this is only a cadaver? Bodies sometimes crystallize under remarkably slight influences; under prolonged vibrations, as in the wire of suspension-bridges; depressions of temperature, like tin; or a simple molecular action, as do arsenious acid and barley-sugar. Glasses, according to the most general opinion, are constituted of an infinite number of interlaced crystals too minute to be distinguished by our microscopes, but which may be forced to arrange themselves in groups, and thus appear visible, by means of a prolonged roasting. In science we must be on our guard against absolutely affirming what our senses do not perceive, but we must be equally wary of supposing that things possess the same limits as the instruments which we are using to-day, but which the ingenuity of an inventor may bring to a greater perfection to-morrow.

In any case, especially if we restrict individuality to the definite chemical compound, the species is more clear in mineralogy than in biology, because it is more simple. The study of the structure of minerals is comparative inorganic anatomy, and, when crystallographers measure angles, refer the infinite variety of different solids to regular geometrical types, and class them in one or another of the six categories of crystalline systems, they perform the work of anatomists. To cite their names would be to write the history of mineralogy over again. We should have to begin with Erasmus, Bartholin, Huygens, and Stenor, and end with the immense number of those who are now engaged with crystallography.

The crystal does not, then, appear suddenly any more than the plant or the animal. It passes through an embryonic state, the general

study of which is embryology. And who knows whether the embryology of organic bodies, that science still wrapped in so much darkness, may not be illuminated with an unanticipated light when it shall be able to take for the basis of its investigations the results furnished by the embryology of inorganic bodies? MM. Monnier and Vogt have already imitated, by means of inorganic salts reacting upon one another, the forms of organic cells, and in a work, the summary of which was published in 1882 in the "Comptes Rendus" of the French Academy of Sciences, under the title of "The Artificial Production of the Forms of the Organic Elements," they have examined in detail these extremely delicate phenomena which carry us back toward the elementary origin of beings.

All beings are subject to certain general laws. Experiments in supersaturation show the action of continuity exercised by the parent upon the descendant which resembles it, and the conditions of existence, if not identical, are at least comparable for all. The crystal, in the solution into which it is plunged, increases by taking up, by means of a labor inherent to its nature, the particles which are suitable to it, and which become thus the food upon which it is supported. The struggle for existence is universal. Henri Sainte-Claire Deville announced the application of this thought to the mineral kingdom when, pointing to the iron tubes in his laboratory in which crystals were alternately heated and cooled, he remarked, sententiously, "The large crystals eat up the little ones." All bodies are subject to the action of ambient conditions. Among these incessant variations, these reciprocal influences of the medium upon the being and of the being upon the medium, are certain situations of greater stability, or positions of momentary equilibrium in which the body seems to persist, when an effort, a more considerable change, is needed to displace it. This equilibrium is not absolute. Susceptibility constantly exists, but it is manifested more or less clearly, so that we can define mineralogy as the study of the effects produced by different causes upon minerals. Sometimes a relaxation is apparent, a comparative retardation, a slumber, a lethargy, a catalepsy, a condition of real or apparent death. It is hard to express our idea by using such words as death or destruction, which possess a common acceptation that we are obliged, perforce, to stretch. "If we dry or deprive of heat certain inferior beings, frogs, aquatic insects, or some eggs," says Claus, in his "Zoölogy," "we can interrupt the vital functions for months and years, and still restore the life by returning the water and the heat. While there are some seeds that lose their germinating qualities after a few days, melon-seeds and beans are known to have grown after thirty or forty years, and even seeds of heliotrope and lucern that were found in the Gallo-Roman tombs, and were therefore fifteen or sixteen hundred years old, have been made to grow." The crystal, withdrawn from the mother-solution, and deprived of food, ceases to develop; it continues the same

in appearance, although its immobility is not absolute. If the air becomes moist, it falls into deliquescence ; if too dry, into efflorescence. It does not possess the same volume nor the same angles in summer and in winter. Still, these changes are relatively slight, and if we take our crystal from the drawer, in which it has been kept inert, and put it in more favorable conditions, it will resume its development. Heated too much, attacked by a strong enough chemical agent, or subjected to any excessive influence, the body will be destroyed, and will experience the more profound modification commonly called death.

May we not also say that there are diseases of minerals? Can we not recognize in some of them a tendency to a healing, or, in other words, to a return toward the state of primitive equilibrium when the cause of the evil has disappeared—provided, always, that the divergence from that position of equilibrium has not been too considerable? We may cite in illustration of this hypothesis the numerous cases of mutilations of crystals that have been studied by Leblanc, Beudant, Lavalle, De Sénarmont, and M. Pasteur, on the bimalate of ammonia ground up in polishing, nitrate of lead, sea-salt, hydrochlorate of ammonia, or crystals of white potash alum, mutilated in certain lines, which, immersed anew in a solution colored with chrome alum, have their wounds cicatrized before resuming their interrupted development—a phenomenon which is made visible by the difference in color of the two isomorphous salts. These curved, twisted, deformed, and monstrous crystals, diverted from regularity by causes most usually unknown, but of which science is on the way toward discovery, would make, in regard to their malformations, objects of a mineral teratology.

The higher the stages of development which bodies reach, the more their forms become complicated ; here, again, the chain seems to be uninterrupted. I thought I had substantiated a tendency toward perfection in the curious so-called mimetic appearances which plagiocase feldspar, leucite, analcime, senarmentite, and many other minerals exhibit, phenomena by which many crystals belonging to a more complicated system group themselves in a determined number, so as to offer the deceptive appearance of a single individual belonging to a less complicated system. M. Pilo, on the other hand, sees in this march toward a more simple form a retrogradation, an inverse phenomenon of degeneracy, which he compares to atavism. I yield to his view, and in doing this take notice of one other correlation between the two opposite extremities in the scale of beings. There is also a passage of crystalline systems among themselves, and each property effects this passage separately—a displacement of optical axes which, diminishing their angle, transforms a biaxial crystal to a uniaxial one, successively for each of the colors of the spectrum ; an unequal thermic dilatation, positive or negative, following the three axes

of elasticity, null in some directions; variation in the mutual inclination of the facets; in the same system, a transition from hemihedral to holohedral forms by sharp grouping in some cases, by striæ like those of pyrites and quartz, of holohedral forms to forms hemitropal in different degrees, and to hemimorphal forms. The complication goes on increasing.

We will end by a last trait of analogy. Just as some animals and plants, when they are by any cause placed in a medium offering the largest sum of propitious conditions, attest the excellence of that medium by a more complete development of the individual and of the number of individuals; as there exists a zoölogical geography and a botanical geography, which distinguishes and enumerates for each species the most favored or most favorable regions—there exists also a mineralogical geography, which fixes the cantonment of particular minerals in certain countries. In the Island of Elba, more than anywhere else, is found oligist iron; in the Hartz and the Ural, ores, and native metals; in India, Brazil, and South Africa, gems and diamonds; in California and Australia, gold; in Canada and Chili, copper; in Siberia, malachite; and in Iceland, Iceland-spar. This study has been elaborated for some substances—tin, for example—in the admirable labors of Élie de Beaumont.

Thus, since we have for minerals an embryology, an anatomy, a nosology, a teratology, and a geography, a vast assemblage of facts many of which are known and more unknown, we may also conclude upon the existence of a mineral biology. When every one of the chapters which it embodies shall have been treated experimentally, we may come into a condition to formulate its laws. The artificial barriers raised by our ignorance between the different branches of knowledge will one after another be leveled. Natural history will become easy, like physics and chemistry, now that physics and chemistry, as Lagrange foresaw, have become easy; or, rather, all the sciences will be consolidated into one science, which will be one because matter, the object of its investigations, is one. Every time the mind of the investigator escapes beyond the work of detail which he daily performs in his laboratory, the contemplation of an ideal far removed, but which he is certain he or those who will follow him will attain, gives him new strength to go back to that daily labor, marks an advance, infinitely little but certain, toward that ideal. A glance over its history shows how mineralogy has grown. It seems as if it were conscious of the end toward which it is tending, of connecting the sciences called natural with the exact sciences. As M. Pilo has happily remarked, mineralogy has traversed the period of magic with the alchemists, the empiric period with the experimenters of the seventeenth century, the naturalist's period with Linnæus, Buffon, and Werner, the geometric period with Haüy, Delafosse, and Bravais, the chemical period with Berzelius, and the physical period with Fresnel,

Mitscherlich, and De Sénarmont. It is now time for it, gathering up the scattered results it has collected, and adding new conquests to them, to enter resolutely into the biological period.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

SKETCH OF GERARD MERCATOR.

GERARD MERCATOR, the distinguished geographer and author of the system of map-drawing which bears his name, was born at Rupelmonde, Flanders, March 5, 1512, and died at Duisburg, December 2, 1594. The name by which he is known, Mercator, is a translation into Latin of his real name, which is given by one authority as Kaufmann, by others as Krämer, or De Cremer, all meaning merchant or trader. He was first sent to school at Bois-le-Duc, under Macropedius, but afterward went to Louvain, where he applied himself to the study of philosophy and mathematics so earnestly that he was prone to let his days pass without eating and his nights without sleeping, and had to be reminded that those duties should be attended to. Of the nature and influence of his studies at Louvain an interesting incident is related by his biographer, Van Raemdonck ("Gérard Mercator, sa Vie et ses Œuvres"), which also illustrates a striking trait of his character. The Bible to him was a book of authority, and he had conceived a high respect and formed a fixed attachment for its text. He had also been taught the physics of Aristotle, which then prevailed in all the schools. His studies in the book of Genesis soon showed him that there were many discrepancies between the cosmogony of Moses and the teachings of Aristotle and other accepted philosophers; thus a dilemma was presented to him. He would not give up his Bible; must he give up Aristotle? To relieve himself from his embarrassment, he took a course, says Van Raemdonck, "that was as Christian as it was logical. Believing in the inspiration of the Bible, and convinced of man's fallibility, he ventured to doubt the orthodoxy of the philosophers, resolved to revise all his accepted opinions, and, with his reason as his only guide, undertook to penetrate for himself the mysteries of Nature." He went to work to construct a new cosmogony. In order to escape critical annoyance, he left Louvain and retired to Antwerp, where he hired rooms and gave himself up to his investigations on this subject. There he framed a cosmogony which agreed at once with his reason and with the Bible. When he returned to Louvain, the doctors of the university, shocked at his boldness in questioning what was almost universally received, were ready to attack his new doctrines, anticipating their immediate publication. But he kept his own counsel, and held his cosmogony in

his portfolio till such time as he should judge best to make it known. Being obliged to make his living by manual labor, Mercator selected the making of mathematical instruments, with the designing, engraving, and illumination of maps, as his business. He thus entered upon a career which he never left, and which was destined to bring him fortune and glory. In order better to qualify himself for doing this work, he began a thorough course of mathematics. He studied with Gemma le Frison, who was in the habit of giving lessons at his house to a number of high-born pupils, and practiced engraving with him. He made rapid progress, and was able in a short time, having been licensed by the university, himself to give lessons in geography and astronomy; and he made with a precision which was remarkable at that time the instruments which his pupils had to use. In 1541 he presented to Cardinal de Granville a very handsomely executed terrestrial globe, with which his Grace was so well pleased that he introduced the author of it to the Emperor Charles V. He afterward entered the service of that prince, but it is not exactly known in what particular capacity. He is styled in his epitaph *imperatoris domesticus*, but that merely signified that he was attached to the imperial household. He made for his Majesty two other globes, a celestial one of glass, and a terrestrial globe of wood, which were greatly admired as superior to any specimens that had been before produced. They were unfortunately destroyed in the wars by which the Low Countries were afterward overrun. In 1559 he removed to Duisburg, where the Duke of Juliers and Cleves was contemplating the establishment of a university, and had assigned an honorable position in it to Mercator. The duke conferred upon him the appointment and title of his cosmographer. He published at that place a large number of maps, but delayed the publication of his atlas for a considerable time, out of regard to his friend Ortelius, who had also prepared a set of maps, and through Mercator's accommodating spirit was given an opportunity to work off his stock without the embarrassment of competition. It is to Mercator and Ortelius that the world owes the enfranchisement of geography from the errors ingrafted upon it by Ptolemy; and the maps of these two fellow-workers were the most exact known till those of Guillaume de l'Isle and D'Anville were published.

Geography was in his time a mixture of facts and fancies, much of what was taught in it having no better authority than old-time traditions and the fabulous stories of travelers who addressed themselves more to exciting wonder than to telling the truth. Maps were in a worse condition than the descriptive accounts, and gave the most erroneous possible views of the relative situation of the various parts of the earth. It was Mercator's work, to adapt an expression of Malte-Brun's, to demonstrate the extreme imperfection of the systems of the ancients and provoke their abolition. Modern geography, this distinguished

authority on the subject adds, dates from his time. He seems to have had a strong natural taste for the study of this science, to which he himself testified when he said, in the preface to his "Chronology": "I consecrate myself wholly to that study, so beautiful, so useful, and at the same time so difficult. Nothing in the world is so pleasant to me. In fact, compared with it, other occupations, no matter how necessary they may be, are irksome to me." In his opinion, a knowledge of geography was indispensable to successful government and lucrative commerce. "Without maps, giving visible representations of the whole of an empire and its different countries," he said, "merchants would not be able to reach the richest and most important lands, to trade there, and bring all the earth into fraternity with Europe; and, without them, princes could only with difficulty and by means of intermediaries, often of doubtful fidelity, arrive at safe and stable decisions respecting the government of their dominions." Thus, availing himself of the instructions he had received from Gemma le Frison, and having served no other apprenticeship in the art, he began, about 1537, to design on paper, and then to engrave on copper, and illuminate the chorography of various countries. "The skillful instrument-maker became also in a short time an accomplished map-engraver; and no maps of his time were comparable in workmanship with his."

Mercator's principal title to fame rests upon his invention of the method of drawing maps, which is known as Mercator's Projection. Under this system the map represents the earth as an unrolled cylinder, and the poles are remanded to infinity. The parallels of latitude and the meridians are drawn as straight lines, crossing one another at right angles. This method gives a tolerably fair representation, and accurate enough for practical purposes in the neighborhood of the equator and for about thirty degrees on either side of it; but, in approaching the poles, the proportions of the parts are distorted. The length of the degrees of longitude and of the parallels is exaggerated—vastly in the immediate neighborhood of the pole—for to preserve the parallelism of the meridians and their perpendicularity to the parallels of latitude, the degrees must be drawn of equal length in all parts of the map. The plan has, however, the great practical advantage for sailors of causing the curve drawn on the sphere crossing all the meridians at the same angle—the loxodromatic curve, which a vessel would describe in sailing around the earth without changing its course—to be projected into a straight line. It thus furnishes a way in which the bearing of a vessel sailing directly between two distant ports can be clearly discerned on the map. While Mercator was successful in executing the designs of his maps on this method, he was not able to explain its theory, or at least did not explain it. The explanation was given by Edward Wright, in 1599, in his "Correction of Errors in Navigation," and from this circumstance the method was long known to the English as Wright's Projection.

Mercator expressed a full appreciation of the importance of astronomy as connected with geography. That science was then cultivated largely in connection with astrology and was invoked in the solution of the most trivial questions. For this he had a profound contempt, while he believed in the significance of celestial phenomena and extolled the study of them. "The purposes for which the luminaries of the sky are created," he said, "are much higher than to assist in the predictions of the astrologers. Those lights exist to reveal to man the omnipotence, the majesty, and the divinity of his Creator, and not to be at the service of the vanity of the astrologers. They exist to mark the revolutions of the centuries; it is for this that they become obscured and are dissolved to announce the end of ages and proclaim judgment upon the world. It was thus that in the time of the passion of Christ, when the law was to be changed, Dionysius the Areopagite was permitted to see an eclipse. It was thus that Joshua perceived the astounding action of the hand of God in the spectacle of the sun. These bodies exist to mark the limits of days and years; and the stars, which glow by night in the firmament, shine upon the earth, and point out by their position the annual course of the sun." Mercator had collated the results of his studies on this subject, and had announced for publication a work embodying them, when death prevented his carrying out his intention.

Among the larger works mentioned by various authors as having been executed by Mercator, are the maps of Palestine, Flanders, Europe, Great Britain, Lorraine, the terrestrial and celestial globes already mentioned, and a great planisphere. These were all larger than the maps of the atlas. None of them, except the planisphere, are now known to be in existence. A few loose sheets from the plates of the atlas, preserved in collections at Brussels, London, the Hague, and St. Petersburg, constitute the chief part of the works of this class known to be by him that are now extant. For his chorography of Palestine —"Amplissima Terræ Sanctæ Descriptio" ("Most Ample Description of the Holy Land"), Mercator had to depend upon the best authorities he could command—"the testimony of an unknown traveler"—and they have not been identified. He is credited, however, with having made good use of the critical faculty in the composition of the work. It had the honor of having been sought for by the learned André Masius for the illustration of his commentary on the book of Joshua, who, in a letter to Georges Cassander, spoke of it in the most complimentary terms. The map of Flanders was produced after the spending of three years in personal surveys of the country, and appeared in 1540. It exists now only in reduced copies in the "Theatrum" of Ortelius and in Mercator's atlas; but the historian Jacques Marchantius, who had seen it, says that it surpassed all the maps of all other geographers. The map of Lorraine was also made after personal surveys, in the prosecution of which the author appears to have been exposed to

some danger. When the map of Europe appeared in 1554, with Ptolemy's errors corrected and the continent shown in something like its real extent and proportions, the learned of all countries, according to Ghymmius, pronounced such extravagant eulogies upon it that one might have thought that no such perfect work had ever before seen the light. A single copy of his great "Mappa Monde" exists in the Bibliothèque Impériale of Paris. It is two metres by one metre thirty-two centimetres, or about six feet and a half by four feet, in dimensions, and shows the world from 80° north to 66° 30′ south. It includes three continents or land-masses—the Old World, America, and a southern continent, which Mercator conceived to be necessary to the balancing of the globe, but which had not yet been found, and which is only imperfectly represented by Australia and the larger islands and the south polar lands. The regions around the pole could not be given, on account of the exaggeration of the degrees on the plane projection, so a special supplementary map was provided for them. As not much was known about these regions, not much could be shown, and the little that could be, with no great accuracy. Behring Strait had not yet assumed definite form in the minds of geographers, but Mercator, thinking there ought to be some such body in that region, marked one on the map. In the main map also, some curious features were marked in the islands of the ocean, on the word of travelers, that have not yet been verified.

The "Atlas" was published in 1595, although several of the maps had already been published separately, that of France in 1585, and the map of Europe in 1572. Larger and smaller forms of the work were published in Latin, French, German, Flemish, and Turkish, in at least fifty editions. The more important editions were published by Hondius, at Amsterdam. That of 1623 had one hundred and fifty-six maps, and the edition of 1630 was prefaced by a biography of Mercator, by Gautier Ghymm (Ghymmius). This work included accounts of the political and the physical geography of the countries described.

To the uniform edition of his maps, Mercator prefixed an essay, "De creatione ac fabrica mundi" ("Concerning the Creation and Structure of the World"), the theological doctrines of which excited some question. But Van Raemdonck, his admiring biographer, says of it: "We have hardly been able to disengage ourself from the reading of it, so much does it attach, lead on, and transport us. In turning over those noble and pious pages, we might have thought we were reading a sacred canticle, a real hymn to the Lord. Invocation of divinity, holiness of purpose, grandeur of conceptions and ideas, sublime style, and enthusiasm—all are there and help to make us believe, with Dr. Solenander, that Mercator speaks in this book as an inspired prophet, as one who has been initiated by God himself into the mystery of the origin of the world."

In preparing his maps, Mercator had to give attention to the study of the best methods of lettering. The results of these studies were published for the information of the public, in an essay on italic and cursive letters—"Ratio scribendarum literarum latinarum quas italicas cursoriasque vocant"—which was a treatise on calligraphy and much more; for it embodied the fruit of much thought and careful investigation on a subject which was of great importance, to him at least.

The services of Mercator were in frequent demand for the preparation of maps of private estates, and from this occupation he was able to meet the current expenses of his living and his family, and derived a considerable income.

Mercator's most important work, after his maps and atlases, was his chronology: "Chronologia a Mundi exordio ex eclipsibus et observationibus ac bibliis sacris" ("Chronology from the Beginning of the World; from Eclipses and Observations, and Holy Books"); Cologne, 1568; Basle, 1577. It was an elaborate work, the result of four years of labor, and gave 3965 years from the creation to the birth of Christ. Scaliger expressed a high opinion of it, and Lenglet Dufresnoy spoke of it as clear but dry; but it was pronounced by one of the best judges of the time, Onuphre Panvini, of Verona, author of several historical and chronological books, preferable to all existing chronologies. In the preface to this work he sketched a plan of a universal cosmography. Repeating this plan in 1585, he described it as intended to include, first, the form of the world and the general distribution of its parts; second, the order and motions of the heavenly bodies; third, their nature and radiation, and the concurrence of their influences, from which may be derived a veritable astrology; fourth, the elements; fifth, descriptions of kingdoms and of the whole earth; sixth, the genalogies of princes from the beginning of the world, with the emigrations of the peoples, their abodes, their first inventions, and antiquities. This order was not, however, observed in actual publication.

Piety was a predominant feature in all of Mercator's life. To extol the works of God, he said, "to exhibit the infinite divine wisdom and inexhaustible goodness by showing how all things in their composition concur to glorify him and reveal his incomprehensible providence—such is the end toward which I shall direct all my efforts, all my readings, and all my meditations."

This feeling it was, probably, that impelled him, in the latter part of his life, to give attention to theological questions, and which prompted the composition of his "Harmony of the Gospels" ("Harmonia Evangelistarum"), which was published at Duisburg in 1592.

He seems to have had opinions of his own on theological subjects, even earlier in his life—and that was against the order of society. He

was arrested in 1544, while residing at Louvain, by order of some one having authority in the prosecution of heretics, and imprisoned, on a charge of being infected with the Lutheran doctrines. Twenty-eight other citizens were taken under the same order, but Mercator, being at Rupelmonde to look after the estate that had been left him by his great-uncle, escaped till he was found. His absence from home was construed into a confession of guilt by flight. His parish priest immediately addressed a letter to the authorities, testifying that "Gérard Mercator enjoys a good reputation, lives a religious and honorable life at Louvain, and is in no way infected with heresy"; and that he was always to be found at home, except when absent on legitimate business. The conservator of the university demanded that he be tried, if he was to be tried, before the court of that institution, within whose jurisdiction he resided; and the rector of the university interceded in his behalf. But all these protests were without immediate effect. He was kept in custody for four months, and then discharged, in the absence of evidence against him—and, perhaps, by the force of the evidence for him.

Two works of Mercator's remain to be mentioned. They are his edition of Ptolemy's "Geography" ("Tabulæ Geographicæ ad mentem Ptolemæi restitutæ et emendatæ"), with twenty-seven maps; and his "De usu annuli astronomici" ("Concerning the Use of the Astronomical Ring"), an explanation of the horizon, meridian, and other rings of his globes.

Mercator is described as having been small, but well shaped. He regarded material life as a necessity and not as an enjoyment, and was strictly sober in his repasts. But the gravity of his labors did not exclude gayety; and, in whatever festivities, official or private, he participated, he contributed to the general good cheer with his sprightly humor, and yielded to the tastes of the others such conformity as was consistent with his health and the precepts of religion. He was vivacious and adroit in discussion, easy and agreeable in conversation, and knew no greater pleasure than to talk familiarly in the society of the learned concerning subjects of knowledge. Observing moderation in good fortune, resigned and patient in adversity, he constantly preserved the calm that was necessary and favorable to his studies. And he was distinguished for his devotion to the interests of his country.

CORRESPONDENCE.

"AN ECONOMIC STUDY OF MEXICO."

Messrs. Editors:

I HAVE read with interest the article under the above title published by Mr. David A. Wells in the April "Popular Science Monthly," and, while I admire in it the author's smoothness and facility of style, I can not afford, as a Mexican, to let it pass without at least pointing out some of its many inaccuracies in regard to history and current facts.

It does not require great acuteness of mind to perceive, *prima facie*, that, in preparing his article, Mr. Wells has been more careful to pick out the best way of showing his predisposition against Mexico, than to make an accurate representation of things as they really are, and as they have been narrated by more competent and judicious persons. I am far from affirming that all the assertions of Mr. Wells are equally deficient in justice and truth, but I do hold that in no instance do we see him disposed to point out our *good things* among the *countless bad ones* he so eagerly mentions.

If I were to review Mr. Wells's "Economic Study of Mexico," I should begin by saying that while he thinks that "the majority of those who in recent years have visited that country would seem to have brought to their eyes the power of seeing little else than the picturesque side of things," I believe that he has exerted his powers of vision to see nothing else than the gloomy side of them, for so it must appear to everybody conversant with our modern history who may peruse the "Economic Study of Mexico."

According to Mr. Wells's notions, Mexico is one of the most stupid, the most insecure, the poorest, the most arid, the most miserable countries of our planet, and all candid readers who may be pleased to read his thrilling descriptions might think that they are the product of long, careful study and extensive travels, and not of a rapid pleasure trip along the Mexican Central and National Railroads. But to the thoughtful and intelligent reader it will rather appear a ridiculous pretension to try to demolish, with such an imperfect and unqualified knowledge, all that thoroughly competent men have written in regard to the immense natural resources of this country. It may be admitted that Mexico, as a nation, is poor, but as a country it may be classed among the richest in the world, despite the efforts of Mr. Wells to establish the contrary. Has Mr. Wells ever read the writings of Humboldt, Burckhardt, Egloffstein, and many others, about the wonderful natural richness of this country? Has he ever consulted the official statistics and reports? I think not, or else he enforces with his example the truth of that old saying that "the most blind is the one who does not want to see"; or perhaps Mr. Wells, considering himself the *ne plus ultra* in matters of authority, will emphatically assert that the writings of those great men are mere stories, destitute of all value, or, as he says of the historic writings of Mr. Prescott, are nothing more than "charming romances." It is very easy to dispose of authorities in this peculiar way of Mr. Wells, but the real damage inflicted by so doing is scarcely greater than that which would result if I were to try to stop the course of the sun with my hand.

It is very striking to see Mr. Wells completely disregarding our natural resources, especially our mines. In a period of one hundred and ten years (1690–1800) of the colonial epoch the mines of Mexico produced, in gold and silver, the sum of $1,499,435,898.* The pure mines of Guanajuato produced in a period of forty years (1766–1808) the respectable amount of $165,002,145;† and the Valenciana mine alone yielded from 1766 to 1826, in round numbers, the sum of $226,000,000.‡ Next in importance is the Zacatecas district, which, according to respectable authorities, produced, from 1548 to 1883, the astonishing sum of $1,000,000,000.§ But it would be an endless task to pursue our investigations about the many other mining districts of our country which also have yielded immense quantities of silver and gold; and what we have said of Guanajuato and Zacatecas surely will be sufficient to give an idea of the importance of our mines.

Our agriculture, it is true, has not been rightly developed, partly on account of the many revolutions we have had in past years, and partly on account of the fact that our attention is chiefly directed to the mining industries; yet we produce enough wheat, maize, beans, coffee, sugar, etc., for our consumption, and have a regular surplus for exportation. But even if we did not produce a single grain, on account of the imperfect development of our agriculture, the argument would be a very poor one to brandish against the fact that our soil is rich and exuberant.

On account of the same revolutionary state of the country from the epoch of in-

* Humboldt, "Political Essay on New Spain," vol. ii, p. 91.

† Ibid.

‡ Dahlgren, "Historic Mines of Mexico," p. 38.

§ Ibid.

dependence till eight years ago, our highways have been somewhat insecure, especially those more distant from centers of population, but never to the extent asserted by Mr. Wells; and at present I am sure that, in this respect, we are no worse than the United States or any other of the nations called civilized.

It has been always the practice of Americans to despise and abuse Mexicans (of course there are many honorable exceptions to the rule) whenever it was possible to do so, as I had occasion to notice during nearly two years that I lived in San Francisco, California. This, I believe, is a mere question of race, but it none the less awakens a feeling of antagonism, at least among the uneducated classes of Mexicans. The ex-minister to Mexico, Mr. John W. Foster, was not an exception to the rule of what I have said, when he wrote to the merchants of Chicago the exaggerated report to which Mr. Wells alludes. When that memorable piece of Mr. Foster's literary ability was published in the journals of Chicago, ex-deputy Martínez Negrete, of this country, had just arrived in that city, on his return from the Exhibition at Paris in 1878. As soon as he read the unfair communication of Mr. Foster, he made a very patriotic and energetic reply, and published it in one of the evening journals of that city, waiting there for results several days. The fact that there was never an argument adduced against our deputy's article, proved conclusively the lack of truth in Mr. Foster's malicious report. Señor Martínez Negrete, in showing at that time that there were robberies in the United States as well as in Mexico or other countries, among other things pointed out the recent and scandalous fact of the stealing of A. T. Stewart's corpse from the tomb, an event the parallel of which never has occurred in Mexico.

Now let us hear Mr. Wells discourse about the ancient civilization of Mexico: "The general idea is, that the people whom the Spaniards found in Mexico had attained to a degree of civilization that raised them far above the level of the average Indians of North America, more especially in all that pertained to government, architecture, agriculture, manufactures, and the useful arts, and the production and accumulation of property. For all this there is certainly but very little foundation, and the fascinating narrations of Prescott, which have done so much to make what is popularly considered 'Mexican history,' as well as the Spanish chronicles from which Prescott drew his so-called historic data, are, in the opinion of the writer, and with the exception of the military records of the Spaniards, little other than the merest romance, not much more worthy, in fact, of respect and credence, than the equally fascinating stories of 'Sindbad the Sailor.'" Who could refrain from laughing at such a pompous and presumptuous way of dealing with historic matters? Perhaps Mr. Wells blames Mr. Prescott for not having drawn the materials for the "History of the Conquest of Mexico" from the annals of China or Japan. . . . But the most curious thing about Mr. Wells is the boldness with which he rejects the Spanish chronicles and the writings of Prescott without offering any better authority to upset them; he may be a man of unlimited knowledge, but we refuse to adopt him as the standard authority in the "History of Mexico," for which refusal, I am sure, the sensible world will justify us. If Mr. Wells has not learned anything about the advanced civilization of the ancient empires and kingdoms of Mexico, we advise him to read the famous historic writings of Clavijero, Las Casas, Alamán, Orozcoy Berra, and others, and the no less important archæological and philological works of Chavero and Pimentel. There he will find ample evidence of the Indian civilization which he denies now without proof. The facts narrated by the writers cited have been widely illustrated and proved by the majestic and highly interesting ruins of Uxmal, Mitla, Magdalena, and several other places, in the States of Yucatan, Oaxaca, Pueblo, and Sonora, which have attracted so much attention and study from national and foreign archæologists.

From all that I have said it is clearly seen that Mr. Wells has been very hasty and unscrupulous in his article with which he tried to take the public by surprise; but I can assure the readers of the "Monthly" that, if there is any *economy* in Mr. Wells's "Economic Study of Mexico," it is to be found in the amount of truth comprised in the narrations which it contains.

P. F. Mange.

Alámos, Sonora, Mexico, *May* 5, 1886.

EDITOR'S TABLE.

SCIENCE AND THE STATE.

IN this country we have no state Church; but, on the principle perhaps which, whether scientifically true or not, seems often to be illustrated in human affairs, that Nature abhors a vacuum, we have in its stead a very notable development of state science. In other words, our Government no longer assumes to point out to us the

best methods for promoting our spiritual welfare; but it kindly, and in a most paternal spirit, undertakes to show us the true path of intellectual and economic salvation. Formerly it was religion that could not thrive without state support; now it is science. Formerly it was the priest who undertook the solution of all difficult questions and who stood forth as the visible embodiment of authority; to-day it is the director of an official scientific bureau. In former days it was said that all roads led to Rome; to-day in the United States we are rapidly approaching a state of things under which all the paths of science at least will lead to Washington. There it is that a generous Congress—generous with the people's money—votes rich appropriations for work, the nature and scope of which not one member in twenty understands. There it is that the authority resides that can hire scientific labor in every part of the country, and provide a profitable market for all researches, observations, and theories that fall into line with the main doctrines of official science.

When evils reach a certain height they are apt to attract an attention and awaken a resistance that were lacking in their earlier and less threatening stages. A bill, a copy of which is before us, reported by the "Joint Commission on the Coast and Geodetic, the Geological and Hydrographic Surveys and Signal Service," seems to indicate that, as regards the Geological Survey, the point of danger is recognized to have been reached. It bears as its title, "A Bill restricting the Work and Publications of the Geological Survey and for other Purposes." The proposition is to confine the survey for the future to strictly geological work, such as may be necessary for the preparation of a good geological map of the country. According to the terms of the bill, it is not in future to expend any money for paleontological work, "except for the collection, classification, and proper care of fossils and other material." It is not to undertake the general discussion of geological theories, "nor shall it compose, compile, or prepare for publication monographs or bulletins, or other books except an annual report, which shall embrace only the transactions of the bureau for the year and the results thereof." It is further provided that in future "all printing and engraving done for the Geological Survey, the Coast and Geodetic Survey, the Hydrographic Office of the Navy Department, and the Signal Service, shall be estimated for separately and appropriated in detail for each of said bureaus."

Such in substance is the bill. In support of its provisions the chairman of the commission, Mr. H. C. Herbert, gives a summary view of the present extent and variety of the work undertaken by the Geological Survey and of its cost to the country. Taking the latter point first, he shows that, leaving the cost of publications out of the question, the present annual expenditure on the survey amounts to something over half a million dollars, or eighty thousand dollars more than is expended by Great Britain, France, Austria, Switzerland, Italy, Sweden, Russia, Belgium, Norway, Bavaria, Würtemberg, Finland, Canada, Victoria, and Japan taken together. These other countries understand by a Geological Survey, a survey undertaken for the purpose of establishing the main geological features of the national territory; and for this purpose they severally find a moderate expenditure sufficient. In this country a different theory has apparently prevailed. Here a Geological Survey is a bureau invested with authority, and provided with funds, to undertake not only the widest possible investigations of a geological kind, but also minute researches in paleontology, paleobotany, and lithology, together with the study of a variety of economic questions touching on the processes of metallurgy and the general

use of minerals. The director of the survey states that there are in the survey three distinct corps of geologists engaged in the study of economic geology; that there are five distinct paleontologic laboratories; that there are three other laboratories—one chemical, one lithologic, and one physical; that there is an extensive geological library, the librarian having a corps of assistants engaged in bibliography; and that, finally, there is a division of mineral statistics, with a large corps of men engaged in statistical work, the results of which are published in an annual report entitled "Mineral Resources." The annual expenses of publication in connection with the survey are estimated to exceed two hundred thousand dollars. This, however, is exclusive of any expenditure on the geological map of the country, supposed to have been for some years in preparation, but of which no portion has yet been published. The minimum cost of this map is put at $1,690,000 *for plates alone.*

Now, to any reflecting mind it will be quite apparent that the Government can not undertake all this varied scientific work without discouraging the application of private effort and study to the same field. "There is no more reason," says Professor Agassiz, in a letter to Mr. Herbert, "why the Government should publish a history of the mining enterprises of the country than that they should publish a history of manufacturing processes." So with paleontology. "This," according to Professor Agassiz, "is just one of the things which private individuals and learned societies can do just as well as Government." Much of the matter, he further observes, which is published in official bulletins would be published by private individuals or societies if the Government did not lay hold of it; while, on the other hand, much of the stuff which the Government prints would *not* be printed by private individuals or societies *even if they had the necessary funds at their command.* The main result of Government interference would thus appear to be the unnecessary official publication of a certain amount of good matter and the wasteful publication of a quantity of comparatively, if not absolutely, useless matter. Professor Agassiz furnishes to Mr. Herbert a list of forty-eight publications of the Museum of Comparative Zoölogy at Cambridge, and most significantly states that he had "a written proposition from a former Superintendent of the Coast Survey, offering to publish all this as appendices of the Coast Survey reports at Government expense"—an offer which he "respectfully declined to accept."

To show the value placed, in the markets of the world, upon the publications of the Geological Survey, Mr. Herbert calls attention to the fact that, though the law of its organization requires the survey to sell its publications, not exchanged, at cost, and turn the proceeds into the Treasury, the whole amount thus realized in six years was $1,543.10—testifying to an annual demand to the amount of $257.18.

We have thus far referred only to the Geological Survey; but the report before us gives a statement of the total cost of the several surveys organized by the Federal Government, exclusive of the cost of printing. The amount is close upon a million and a half of dollars. That no *adequate* return is being received from this really vast expenditure there is too good reason to believe; but that is not the worst feature of the case. The worst feature is that hinted at by Mr. Herbert when he opportunely reminds us of Buckle's conclusions as to the effects wrought in France by Louis XIVth's patronage of science and art; individual thought and private enterprise were repressed, science and literature were put into bondage and reduced to a state of abject servility. It is this evil, however ridiculous the idea may appear to some, with which we are threatened here. In the field of geology the vast opera-

tions of the Government tend directly to dwarf individual research; geology itself tends to become a purely official science. "We confidently appeal," says Mr. Herbert, "to the best literary and scientific thought of the country to come to our aid and join us in the effort to effect a reform and arrest this pernicious tendency." It is needless to say that "The Popular Science Monthly" most cordially and earnestly indorses this appeal. If we want to preserve our intellectual liberty and encourage individual initiative, we must see to it that we do not establish any scientific pontiffs at Washington. And if in an unguarded moment we have established any such, and given them the means of stretching the arm of authority into every portion of our territory and laying the foundations of the Church of Official Science, the sooner we proceed to recall the powers so dangerously conferred, the better will it be for the commonwealth.

LITERARY NOTICES.

Upland and Meadow. A Poaetquissings Chronicle. By Charles C. Abbott, M. D. New York: Harper & Brothers. Pp. 397.

The readers of the "Monthly" already know much of Dr. Abbott as a naturalist and antiquary; for he has not unfrequently visited our pages, bringing with him contributions, the fruit of his researches among the gravels of the Delaware, and of his rambles along the streams and through the swamps that happen to be near Trenton. An unreflecting reader might think, from the fullness of Dr. Abbott's budgets of Nature-lore, and the variety of interest which they contain, that there must be rare qualities in those particular gravel-beds and swamps, but the thought would not be justified. Presumably they are very much like the gravel-beds and swamps that may be found anywhere else, and the rare quality is in the observer. Dr. Abbott has also rare gifts at description, and the faculty of making his reader conceive the scenes and the curiosities almost as if he were along with his guide and looking at them. These merits of observing power and of description are well exemplified in this volume, which delineates what appear to be about a round year's rambles, with observations of animals and plants, and other objects of scientific interest. Keen observer as Dr. Abbott is, he found those things in the observations and histories of the old men he met that made him sorry that he could see so little, or that he had not lived in times when New Jersey nature was richer; he invariably wished, when he had talked with them, that he had been his own grandfather! Then there were men of his own time who could teach him better than he knew what to see. "To realize what a wealth of animal and vegetable life is ever at hand for him who chooses to study it, let a specialist visit you for a few days. Do not have more than one at a time, or you may be bewildered by their enthusiasm. I have had them come in turn—botanists, conchologists, entomologists, microscopists, and even archæologists. What an array of names to strike terror to the breasts of the timid!—yet they were all human, and talked plain English, and, better than all, were both instructive and amusing." The botanist found a plant not previously known to grow in New Jersey; the conchologist a diminutive bivalve with an enormous name, and microscopic shells whose tongues he had to examine and count their teeth; the entomologist chased insects with the speed of an express train, and caught kinds before unseen; the microscopist dipped up a pint-jar of muddy water, and, examining its contents at leisure, announced new infusoria, novel forms of imperceptible life, and gave to them startling names. So Dr. Abbott, in turn, resolved to be a botanist, a conchologist, a student of insect-life, a microscopist, and an archæologist. Even in winter, he finds Poaetquissings full of life; birds that are supposed to have gone away to the South chirping around and seemingly not troubled by the cold or by any lack of food; fishes under the ice; witch-hazels and chickweed and whitlow-grass and sassafras and alder and skunk-cabbage and dandelion blooming with the snow all around, and other flowers coming in as February and March advance. As the changing season proceeds, there are more

birds and more flowers, fields of various adventure, in climbing trees to get "bird's-eye views," and experiments on birds with looking-glasses in different positions, and with chromos of cats. Nest-building time affords subjects of interest that could not be exhausted in a whole life of observations; and, as the season warms up and passes into summer and then into autumn, and so on to the beginning of winter again, these objects multiply or hold their own, and the problem becomes one of how among so many to select the few that we can give proper attention to. Thus Dr. Abbott has always his eyes full. The plants and birds are with him all the time. Besides these, he keeps company with squirrels and rabbits, toads, crawfish, field-mice, and insects—till, as we close the book with the moaning of the October east wind in the sobbing pines, we are fully agreed with what he has told us in the beginning, that he has "seldom seen a half-acre that was not a 'Zoo,' which the study of a lifetime would fail to exhaust." The London "Academy" pronounces this volume "the most delightful book of the kind which America has given us," and says that "it closely approaches White's 'Selborne.'" Higher praise than that it would be impossible to give, and it is deserved.

Flowers, Fruits, and Leaves. By Sir John Lubbock. London and New York: Macmillan & Co. Pp. 147. Price, $1.25.

Mr. Ruskin has lately lamented a lack of books to teach him natural history. In speaking thus, he ignored some most excellent delineations of the natural world by putting them in a class of which he spoke with contempt, and overlooked others that he might have found. The three lectures embodied in this volume would be helpful to a man honestly making his search. They describe, in the engaging and thoughtful way which is characteristic of all of the author's writing about his observations, what is going on in one department of Nature for the promotion of a particular purpose of its being, and which is visible to every one who will attentively look for it. They present the results of studies of those points in the form, structure, color, and economy of flowers, fruits, and leaves which appear adapted to secure the sound life of the plant and the perpetuation of its species. In flowers, the most conspicuous feature is the adaptation to attract insects and secure cross-fertilization by their agency; whereby the insects, in turn, by fertilizing the largest and most brilliant flowers, have contributed unconsciously, but effectually, to the beauty of our woods and fields. "If seeds and fruits can not vie with flowers in the brilliance and color with which they decorate our gardens and fields, still they surely rival—it would be impossible to excel—them in the almost infinite variety of the problems they present to us, the ingenuity, the interest, and the charm of the beautiful contrivances which they offer for our study and admiration." Of leaves, it seems clear that the innumerable differences between them have reference, "not to any inherent tendency, but to the structure and organization, the habits and requirements of the plants. Of course, it may be that the present form has reference, not to existing but to ancient conditions, which render the problem all the more difficult. Nor do I at all intend to maintain that every form of leaf is, or ever has been, necessarily that best adapted to the circumstances, but only that they are constantly tending to become so, just as water always tends to find its own level. But, however this may be, if my main argument is correct, it opens out a very wide and interesting field of study, for every one of the almost infinite forms of leaves must have some cause and explanation."

Popular Government. By Sir Henry Sumner Maine. New York: Henry Holt & Co. Pp. 261. Price, $2.75.

This work consists of four essays, in which the author, as he did in his "Ancient Law," undertakes to do away with the *a priori* theories conceiving a law and state of nature antecedent to all positive institutions, and a hypothetical system of rights and duties appropriate to the natural condition with which he believes the discussion of the subject has been hampered, and to apply the historical method of inquiry to them. In the first essay, which is on the "Prospects of Popular Government," he assumes to show that, as a matter of fact, that system, since its reintroduction into the world, has proved itself to be extremely fragile. In

the second essay, on the "Nature of Democracy," he gives reasons for thinking that, in the extreme form to which it tends, democracy is, of all kinds of government, by far the most difficult. In a third essay, on the "Age of Progress," he argues that the perpetual change which, as understood in modern times, progress appears to demand is not in harmony with the moral forces ruling human nature, and is apt, therefore, to lead to cruel disappointment or serious disaster. In the fourth essay, in which the Constitution of the United States is examined and analyzed, he aims to show that the birth of that law was in reality natural, from ordinary historical antecedents; and that "its connection with wisdom lay in the skill with which sagacious men, conscious that certain weaknesses which it had inherited would be aggravated by the new circumstances in which it would be placed, provided it with appliances calculated to minimize them or to neutralize them altogether." Its success, and the success of such American institutions as have succeeded, appear to him "to have arisen rather from skillfully applying the curb to popular impulses than from giving them the rein. While the British Constitution has been insensibly transforming itself into a popular government, surrounded on all sides by difficulties, the American Federal Constitution has proved that, nearly a century ago, several expedients were discovered by which some of those difficulties may be greatly mitigated, and some altogether overcome."

Oceana; or, England and her Colonies. By James Anthony Froude. New York: Charles Scribner's Sons. Pp. 396. Price, $2 50.

Mr. Froude's mind has been occupied for many years with questions concerning the destiny of England and her colonies. Are they to remain substantially united, in spirit, aim, enterprise, and political structure, as they are now, each free to act for itself in its own concerns, but all combining for the propagation of Anglo-Saxon power and civilization, or are they destined to drop away from one another and become rivals? The question is one of great importance to Englishmen and to colonists, to us Americans as well as to them, and to all the world and all the friends of civilization and liberty. Many years ago, as a student of England's history, and believing in its future greatness, Mr. Froude imagined for himself the Oceana—a general Anglo-Saxon corporation—that might be. But, having no personal knowledge of the colonies, he could not make definite utterances, or form definite conceptions, concerning it; so he determined "to make a tour among them, to talk to their leading men, see their countries and what they were doing there, learn their feelings," and correct his impressions of what could or could not be done. He was then prevented from prosecuting his journey farther than to the Cape of Good Hope, and was not permitted to complete his design for ten years. "But," he says, "I do not regret the delay. In the interval the colonies have shown more clearly than before that they are as much English as we are, and deny our right to part with them. At home the advocates of separation have been forced into silence, and the interest in the subject has grown into practical anxiety. The union which so many of us now hope for may prove an illusion, after all. . . . However this may be, in the closing years of my own life I have secured for myself a delightful experience. I have traveled through lands where patriotism is not a sentiment to be laughed at," but an active passion, where "children grow who seem once more to understand what was meant by 'merry England.'" The book includes observations at sea, in the Cape Colony, in the several Australian colonies, New Zealand, and the United States, covering all the phases of the subject which was uppermost in the author's mind, besides many subjects not directly related to it. Of the United States, Mr. Froude expressses the opinion that "the problem of how to combine a number of self-governed communities into a single commonwealth, which now lies before Englishmen who desire to see a federation of the empire, has been solved, and solved completely, in the American Union." In logical conclusion, "it is something to have seen with our own eyes that there are other Englands besides the old one, where the race is thriving with all its ancient characteristics," and, "let Fate do its worst, the

family of Oceana is still growing, and will have a sovereign voice in the coming fortunes of mankind."

The Adirondacks as a Health Resort. Edited and compiled by Joseph W. Stickler, M. D. New York: G. P. Putnam's Sons. Pp. 198. Price, $1.

The purpose of this work is to show the benefit to be derived from a sojourn in the wilderness, in cases of pulmonary phthisis, acute and chronic bronchitis, asthma, hay-fever, and various nervous affections. The author regards it as a fact that climate plays a very important part in the treatment of certain morbid states of the system, particularly in catarrhal affections of the respiratory apparatus and various forms of nervous disease. He relates as of his own experience that he obtained immediate and permanent relief in bronchitis from a sojourn in the Adirondacks. He also met, while there, several invalids who, having been in a precarious state of health, had been similarly relieved during their sojourn. He accordingly requested various persons, who had tried a change of climate as a means of regaining health, to give him honest expressions of their experience while in the region of the Adirondacks. This book is compiled from their letters as they were sent to him.

What does History teach? By John Stuart Blackie. New York: Charles Scribner's Sons. Pp. 123. Price, 75 cents.

The substance of this book was delivered in two lectures before the Philosophical Institution of Edinburgh, the first of which related to the lessons taught for the state, and the second to those taught for the Church. In the former category is the teaching that the family is the basis of the state and society. From the history of the downfall of Greece is drawn the lesson of failure and disaster brought about by the want of unity between the several states; from the fate of the Roman Republic that of the evil engendered by the perpetual conflict between the aristocracy and democracy. From these lessons and other examples, the author deduces a conclusion favorable to the security afforded by the English system, as preferable to what a democracy can offer; yet there may be an exceptional case in the United States, where "the experiment of a great democratic republic for the first time in the history of the world—for Rome in its best times, as we have seen, was an aristocracy—will be looked on by all lovers of their species with the most kindly curiosity and the most hopeful sympathy. Here we have the stout, self-reliant, sober-minded Anglo-Saxon stock, well trained in the process of the ages to the difficult art of self-government; here we have a Constitution framed with the most cautious consideration, and with the most effective checks against the dangers of an overriding democracy; here also a people as free from any imminent external danger as they have unlimited scope for internal progress. Under no circumstances could the experiment of self-government on a great scale have been made with a more promising start. No doubt they have a difficult and slippery problem to perform." To the Church are taught the lessons of avoiding controversy and of making religion practical.

Transactions of the Anthropological Society of Washington. Vol. III. November 6, 1883, to May 19, 1885. Washington: Smithsonian Institution. Pp. 204.

The number and scope of the papers printed in this volume, and the breadth of the discussions upon them, show the Anthropological Society to be an active body and earnestly interested in its work. A considerable number of the papers relate to American anthropology, a branch of the science to which this society may properly devote special attention, and for the study of which it has great advantages in the inclusion among its members of so many persons who are or have been connected with the geological survey. Many of the papers and the discussions upon them relate directly or indirectly to the mounds and the mound-builders, and frequently call up the question whether the mound-builders were identical with our Indians, or were of an earlier and superior race. Much may be found here to have been said on both sides of this subject. Among the other papers are some by Mr. Lester F. Ward from the mental side of anthropological study; an address by Mr. E. B. Tylor on "How the

Problems of American Anthropology present themselves to the English Mind"; an essay by Mr. F. A. Seeley on "The Genesis of Inventions"; and a presidential address by J. W. Powell on "From Savagery to Barbarism."

Essays on Educational Reformers. By Robert Hebert Quick. Syracuse, N. Y.: C. W. Bardeen. Pp. 330. Price, $1.50.

The author takes for the motto of his essays the words of Dr. Arnold: "It is clear that, in whatever it is our duty to act, those matters also it is our duty to study." Being a teacher, he considers it his duty to study what has been done to advance the art of teaching, and this he does by studying the lives of those who have introduced new features into the work of teaching and examining their work. In the list are included the schools of the Jesuits, Roger Ascham, Montaigne, Ratich, Milton, Comenius, Locke, Rousseau, Basedow, Pestalozzi, Jacolot, and Herbert Spencer. While the author differs from Mr. Spencer in some of his conclusions, he agrees with him "that we are bound to inquire into the relative value of knowledges, and if we take, as I should willingly do, Mr. Spencer's test, and ask how does this or that knowledge influence action (including in our inquiry its influence on mind and character, through which it bears upon action), I think we should banish from our schools much that has hitherto been taught in them." In a chapter of "Thoughts and Suggestions" a consideration of the ordinary methods of school-teaching leads to the conclusion that in subjects other than classics and mathematics they are very commonly a failure, and a failure the teaching "must remain until boys can be got to work with a will—in other words, to feel an interest in the subjects taught." To this end, and to make the instruction serve its purpose, the effort should be made to teach things rather than words, and of things, not the dry details of the outside, but those points which concern their essence.

The Late Mrs. Null. By Frank R. Stockton. New York: Charles Scribner's Sons. Pp. 437. Price, $1.50.

Mr. Stockton is the author of "Rudder Grange," a short story, or episode, of domestic life, which has been commended in the "Monthly" as full of harmless though somewhat extravagant fun; and he is well known as the successful author of other sketches which furnish enjoyable—though idle—reading. In "The Late Mrs. Null" he attempts a more elaborate story, or "his first novel."

Hobbes. By George Croom Robertson. Edinburgh and London: William Blackwood & Sons. Pp. 240, with Portrait.

This is the tenth in the series of "Philosophical Classics for English Readers," by various authors, edited by Dr. William Knight, and has been preceded by volumes on Descartes, Butler, Berkeley, Fichte, Kant, Hamilton, Hegel, Leibnitz, and Vico. Whatever may be the merits of Hobbes's work, he has, as the author observes, left a broad mark in the history of the English mind. It is sought in this book to bring together all the previously known or now discoverable facts of his life, and to give some kind of fairly balanced representation of the whole range of his thought, instead of dwelling only upon those humanistic portions of it by which he has commonly been judged. The account of his "System" has been imbedded in the "Life," because, "more than of any other philosopher, it can be said of Hobbes that the key to a right understanding of his thought "is to be found in his personal circumstances and the events of his time." If a man's influence, the author observes in the concluding chapter of the book, and after having related the controversies he provoked, "is to be measured not least by the opposition that he arouses, we have already had proof that few thinkers have left a deeper trace upon their time than Hobbes." It was not only at home that he exerted influence or called forth strenuous hostility, but abroad as well. In England, so far as he has exerted an influence in philosophy proper, "it has been of the indirect kind wrought through psychological science. As psychology has a voice in the determination of ultimate philosophical notions that belongs to no other positive science, Hobbes has done more for philosophy by promoting the positive investigation of mental functions than by the abstract definitions of his own 'First Philosophy,' acutely conceived as these al-

ways were; when the accidental features of Hobbes's ethico-political ideas—due to time and circumstances and personal temperaments—are discounted, it is not difficult to understand how it should have been philosophical results of the school of Bentham that first gave them effective currency"; and, finally, it should be said that, "with enemies and friends alike, Hobbes's power has been due not least to the rare excellence of his literary style."

Appalachia. March, 1886. Pp. 108. Price, 50 cents. Register of the Appalachian Mountain Club, for 1886. Boston: Appalachian Mountain Club. W. B. Clarke and Carruth. Pp. 40.

The Appalachian Mountain Club was organized in January, 1876, and reorganized and chartered in April, 1878. Its objects, as specified in the By-Laws, are to explore the mountains of New England and the adjacent regions, both for scientific and artistic purposes; and, in general, to cultivate an interest in geographical studies. Its list of members has gradually grown, and now includes six hundred and ninety-three names of members of all classes. It is in relations of correspondence and exchange of publications with seventeen American societies and surveys, and fifteen Alpine clubs, and fifteen geographical societies abroad, besides single exchanges. Its periodical, "Appalachia," is usually published twice a year, four numbers constituting a volume. From the official reports, published in "Appalachia," it appears that the club held thirteen meetings during 1884—nine regular, two special, and two field meetings — the average attendance upon which was more than one hundred. The topographical department of the club is engaged upon a manuscript map of the White Mountains, on a scale of $\frac{1}{50000}$, from data already collected by members. Besides official reports, and reports of the meetings of the club, which themselves embody some papers of interest, the present number of "Appalachia" contains special papers on "The Tripyramid Slides of 1885"; "Earthquakes in New England"; "A Day in Flume Mountain and a Night in the Wilderness"; "Middlesex Fells"; "Accurate Mountain Heights"; and "Mountain Meteorology."

Bulletin of the United States Fish Commission. Vol. V, for 1885. Washington: Government Printing-Office. Pp. 494.

While the present volume of the "Bulletin" does not contain any long and elaborate monographs on some special branch of fish-culture like those which have given unusual value to some of the previous volumes, it is filled with numerous brief articles and extracts from correspondence, reporting progress, or embodying information of practical value. Under the heading of "A Foreigner's Opinion of American Fish-Culture," Sir Lyon Playfair is quoted as saying: "There is an essential difference between the mode of proceeding of the Government of the United States and that of our own country in relation to fisheries. We have had commissions without end, on some of which I have served. Vast bodies of contradictory evidence have been obtained from fishermen, who, I agree with Huxley, know less about fish than the community. Our commissions have led to little useful result. The American commissioners act in a different way. They put questions directly to Nature and not to fishermen. They possess scientific methods, and not those of 'rule of thumb.' They make scientific investigations into the habits, food, geographical distribution of fishes, and into the temperature of the seas and rivers in which they live or spawn. Practical aims and experiments are always kept in view."

The Order of Creation; The Conflict between Genesis and Geology. New York: The "Truth-Seeker" Company. Pp. 178. Price, 75 cents.

This publication contains the articles by Mr. Gladstone and Professor Huxley which have already appeared in the "Monthly," together with Professor Max Müller's and M. Réville's replies to those parts of Mr. Gladstone's observations which bear upon what they have respectively said on the subject in controversy or upon theories to which they adhere; together with a reply by Mrs. E. Lynn Linton to a phrase used by Mr. Gladstone to convey his regret that some writers appear to him to rejoice at the thought that they have got rid of the belief in God.

Wonders of European Art. By Louis Viardot New York: Charles Scribner's Sons. Pp. 335. Price, $1.

This volume is a translation of the second series of the "Merveilles de la Peinture," by M. Viardot, the first part of which has been already published as "Wonders of Italian Art" in Messrs. Scribner's series of "Wonders of Art and Archæology," to which this selection also belongs. It embraces notices of the Spanish, German, Flemish, Dutch, and French schools, in which M. Viardot has critically examined many thousands of the most celebrated paintings.

Elements of Universal History. By Professor H. M. Cottinger. Boston: Charles H. Whiting. Pp. 336. Price, $1.50.

This history is designed for higher institutes in republics and for self-instruction. It presents the story in an easy, flowing style, adapted to attract and hold attention, and the matter is grouped in periods, at the close of each of which is a series of exercises and review questions. The author has failed to avail himself of the recent researches in extremely ancient history, without which no text-book even can now be considered complete, and the picture of Egypt and the Oriental monarchies, whose history is assuming definite form and importance, will be presented in erroneous colors.

Scriptures, Hebrew and Christian. Arranged and edited for Young Readers. By Edward T. Bartlett and John P. Peters. New York: G. P. Putnam's Sons. Vol. I. Pp. 545. Price, $1.50.

The object of this work is to serve as an introduction to the study of the Bible. It is intended to be good for other than young readers; but the wants of that class have been especially had in view. The story is told in the words of the Bible, but with considerable condensation and rearrangement; the purpose having been to bring all that relates to a single event together, and to avoid repetitions. The compilers have endeavored to utilize the best results of critical scholarship; and the merit of what is called the "higher" criticism is recognized to an extent that might astonish some of the more obstinate sticklers for the old. The present volume contains the Hebrew story from the creation to the exile. A second volume will bring the account down to the time of Christ, and a third volume will be made from the New Testament.

The Story of Chaldea. By Zénaïde A. Ragozin. New York: G. P. Putnam's Sons. Pp. 381. Price, $1.50.

This history belongs to the "Story of the Nations" series, a series that is designed for the instruction of the young, and is also good for the old. The history of Chaldea has an interest of its own, because that nation competes with Egypt and China for the honor of being the most ancient nation of which any real historical record has come down to us. It has given us also the oldest positive authentic date in history—3800 b. c. for the date of the reign of Sargon I, as established in a record left by Nabonidus, the last king of Babylon. The present volume relates the history of this nation from the earliest times—the times preceding the dim age of Sargon—to the rise of Assyria, in which that other Sargon, mentioned by Isaiah, plays no unimportant part. The story itself is preceded by an introduction in which are given accounts of Mesopotamia and its mounds covering the ruins of ancient palaces and temples; Layard and his work; the ruins; and the grand library of Assurbanipal at Nineveh, in which are found accounts of that even then extremely ancient period which forms the main subject of the book, to which accounts the books of the Old Testament afford the only parallel.

Did Reis invent a Speaking Telephone? Pp. 18. On Telephone Systems. Pp. 28. By Professor Amos E. Dolbear, College Hill, Mass.

In the first of these pamphlets, Professor Dolbear presents his own testimony and that of several other electricians and professors and students of physics of known reputation, based on their personal examination and experiments, to the effect that Reis's telephone embodied with considerable success the principle of the transmitter. The second pamphlet contains a lecture delivered before the Franklin Institute in December, 1885, in which the various systems of telephone construction and manipulation are examined and compared.

Notes on Certain Maya and Mexican Manuscripts. By Cyrus Thomas. Washington: Government Printing-Office. Pp. 64, with Plates.

The manuscripts examined are the "Tableau des Bacab," a plate of the "Borgian Codex," and a plate of the "Fejervary Codex," all of which are supposed to be calendars. The symbols of the cardinal points are then considered in detail. The object of the study is to deduce some clew as to the connection of the Mayas with the other peoples of their region. On this point the author concludes: "That all the Central American nations had calendars the same in principle as the Mexican, is well known. This of itself would indicate a common origin not so very remote; but when we see two contiguous or neighboring peoples making use of the same conventional signs of a complicated nature down even to the most minute details, and that of a character not comprehensible by the commonalty, we have proof at least of a very intimate relation."

Railroad Terminal Facilities for Handling Freights at the Port of New York. By Gratz Mordecai. New York: "Railroad Gazette." Pp. 68, with Maps.

Mr. Mordecai presents a detailed study of the present terminal facilities of all the railroads centering in New York, with descriptions and maps, for the purpose of preparing a way for the consideration of how they may be improved; or how consolidated into a well-regulated and progressive combination; and he adds suggestions of some particular points in which improvement is desirable and feasible.

The Requisite and Qualifying Conditions of Artesian Wells. By Thomas C. Chamberlin. Washington: Government Printing-Office. Pp. 48, with Plate.

This is one of the papers of the United States Geological Survey. While the basal principles of artesian wells—by which are meant only those that flow at the surface—are simple, the real problems they present are complex. Success or failure is determined by a combination of various conditions rather than by the application of simple principles. It is the purpose of the paper to elucidate those conditions.

Report of the Commissioner of Education for 1883–'84. Washington: Government Printing-Office. Pp. 1214.

The present report contains the usual fullness of special information concerning educational affairs in the United States, and general reports of those of other countries, down to June 30, 1884. The Commissioner remarks upon the improved character of the information brought to his office, and the growth of closer sympathy between the office and those actively engaged in educational work. It is observed that there has been no considerable improvement in methods or progress of education in any quarter of the country during the year to which the aid of the office has not been invoked. Clearer views and more intelligent counsels are also observable with respect to the most critical problems that have been under consideration. The total enrollment of pupils in the public schools of the States and Territories is 10,738,192, and in the private schools, 606,517; in secondary and preparatory schools, 271,215; in 236 women's schools, 30,587; in 370 universities and colleges (collegiate pupils), 32,767; in 255 normal schools, 60,063; in 221 business colleges, 44,074; in 354 Kindergartens, 17,002; in 92 schools of science, 14,769; in 146 theological schools, 5,290; in 47 law-schools, 2,686; in 145 schools of medicine, dentistry, and pharmacy, 15,300; in 31 training-schools for nurses, 579; in 59 schools for the deaf and dumb, 22,515; in 31 schools for the blind, 2,319.

A Manual of Mechanics. By T. M. Goodeve. New York: D. Appleton & Co. Pp. 228. Price, $1.

This manual is designed to be an elementary text-book for students of applied mathematics. It consists of clear, condensed statements of the principles and problems of mechanical science. Elementary principles and definitions are given in an introductory chapter. The chapters that follow treat of "The Parallelogram of Forces"; "The Lever, Parallel Forces, and Couples"; "The Center of Gravity"; "The Conversion of Motion"; "The Principle of Work—Friction"; "Simple Machines"; "The Laws of Falling Bodies—Energy, Motion in a Circle, the Pendulum"; "Ele-

mentary Mechanism" (including the crank and connecting-rod, cams, the heart-wheel, escapements, ratchet-wheels, wheels in trains, the winch or crab, pulley-blocks, the steelyard, lifting-jack, etc.); "Truth of Surface, Strength of Materials, the Lathe"; and "Elementary Mechanics of Liquids and Gases."

Evolution. By Charles F. Deems, LL. D. New York: John W. Lovell Company. Pp. 108. Price, 20 cents.

The author—a well-known minister—whose training and mode of thought have been largely theological, professes that in his examination of the theory of evolution, of which this essay is a part of the fruit, he has endeavored to avoid all dogmatism and special pleading. "His aim has been to ascertain *for himself* just what is the posture of the hypothesis at this time, without much regard as to how it stood in the past, or any regard to its possible future, or any care for the effect which the result of his honest study might have on any scientific, philosophical, or theological opinion previously held by him." He assumes that there is no religious reason for the acceptance or rejection of evolution, and there are no valid sentimental objections to it; but the result of his investigation is the Scotch verdict, "not proven."

The Choice of Books, and other Literary Pieces. By Frederic Harrison. London and New York: Macmillan & Co. Pp. 447.

This volume consists of essays and lectures, written by the author at various times during the last twenty years, and which deal solely with books, art, and history, as distinguished from politics, philosophy, or religion; and which do not touch on any controversy except "the perennial problems presented to us by literature and the study of the past." About one third of the matter is in print for the first time. We have been interested in the essay which gives the name to the volume, and find it pregnant with valuable lessons. The burden of it is, that in the present multiplication of books it is impossible to master a fraction of those which may be helpful to us; then why should we waste our time over reading of any other kind? A short review of all literature, ancient and modern, follows, with hints as to the lots from which we can make the most judicious selections. Among the other "pieces" are a dialogue on "Culture"; "The Life of George Eliot"; "Historic London"; "The Æsthete"; "Bernard of Clairvaux"; "A Few Words" about the eighteenth and about the nineteenth centuries; and two articles—on Froude's "Life of Carlyle," and "Histories of the French Revolution"—which first appeared in the "North American Review."

Poetry as a Representative Art. By George Lansing Raymond. New York: G. P. Putnam's Sons. Pp. 346. Price, $1.75.

The author of this essay is Professor of Oratory and Æsthetics in the College of New Jersey. The work, while it is complete in itself, in the sense that it develops from beginning to end the whole subject of which it treats, is in other senses only one of a series of essays which Mr. Raymond has written, respecting the various arts in their functions of representation, of which he gives a tolerably full list. He sustains the conclusion that while poetry is not, in a technical sense, a useful art, its forms have their uses, and many uses and practical ones, at the basis of which lies "the interpretation of the meaning of nature, natural and human, by those who have learned to interpret it, while striving to have it convey their own meanings." His points and principles, as he deduces them in detail, are copiously illustrated with citations from the poets.

The Fisheries and Fishing Industries of the United States. By George Brown Goode, and a Staff of Associates. Washington: Government Printing-Office. Section 1, Text. Pp. 895. Section 2, 277 Plates.

This elaborate report has been compiled under an arrangement between the United States Fish Commission and the Census Bureau, to prepare as exhaustive an investigation of the objects of the work as possible. The scheme of the investigation as drawn up by Mr. Goode embraced the natural history of marine products; the fishing grounds; the fishermen and fishing towns; apparatus and modes of capture;

products of fisheries; preparation, care, and manufacture of fishery products; and economy of the fisheries. The present volumes relate to the natural history of aquatic animals. For the preparation, the coast, lakes, etc., of the country were mapped off into twenty-four districts, each of which was assigned to a "field assistant" investigator; while another body of assistants were employed in the office.

PUBLICATIONS RECEIVED.

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Corthell, E. L., C. E. Exposition of Errors and Fallacies in Rear-Admiral Ammen's Pamphlet on Nicaragua Canal and Eads Ship Railway. Washington: Gibson Brothers. Pp. 52.

Jameson, J. F., Ph. D. Introduction to the Study of the Political and Constitutional History of the States. Pp. 32. Randall, D. B. A Puritan Colony in Maryland. Pp. 48. Baltimore: N. Murray. 50 cents each.

Martin, H. N., and Brooks, W. K. Studies from the Biological Laboratory of Johns Hopkins University. Vol. III, Nos. 5 and 6. Pp. 48 and 84, with Plates. 50 cents and 60 cents.

The Political Science Quarterly. March, 1886. Vol. I, No. 1. Boston: Ginn & Co. Pp. 152. 75 cents, $3 a year.

Bulletins of the United States Geological Survey, No. 24. List of Marine Mollusca. Pp. 336. No. 25. Present Technical Condition of the Steel Industry. Pp. 85. No. 26, Copper-Smelting. Pp. 107.

Lewis, T. H. Ancient Rock Inscriptions in Eastern Dakota. Pp. 3, with Plate. The Monumental "Tortoise Mounds" of "Decoodah." Pp. 5.

Richards, Edward. Principles and Methods of Soil Analysis. Washington: Government Printing-Office. Pp. 66.

Munroe, Charles E. Notes on the Literature of Explosives. No. 10. Pp. 18.

Comfort, George F. Modern Languages in Education. Syracuse, N. Y.: C. W. Bardeen. Pp. 40. 25 cents.

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Mays, Thomas J. The Analgesic Action of Theine. Pp. 28.

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Nipher, Francis E., and Springer, Frank. Address on the Condition of the State University of Iowa. Pp. 22.

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Becker, George F. Cretaceous Metamorphic Rocks of California. Pp. 10.

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Sabbrin, Celin. Science and Philosophy in Art. Philadelphia: William F. Fell & Co. Pp. 21.

Dolbear, Amos E. On the Conditions that determine the Length of the Spectrum. Pp. 2.

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Hall, G. Stanley, and Jastrow, Joseph. Studies of Rhythm. Pp. 8.

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Outlines of Geology. By James Geikie. LL. D., F. R. S. London: Edward Stanford. 1886. Pp. 427, with 400 Illustrations.

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POPULAR MISCELLANY.

The Chicago Public Schools.—Mr. James R. Doolittle, Jr., President of the Board of Education of Chicago, in his report for the school year 1884–'85, considers briefly but with vigor many interesting points in connection with the school system of that city, which are well worth the attention of school officers generally. He regards the school as a progressive institution, which should look to the future rather than to the past, and, while it takes advantage of all that has been gained, should be on the watch to discover whatever may help to make it more efficient in accomplishing its object—which should be to give youth facility to adjust themselves to the duties and exigencies of life. The board has determined that every one of the grammar-schools shall have a library, concerning the constitution of which the President remarks: "None of the books should be beyond the ordinary capacity of grammar-school children. In fact, they should be much easier to comprehend and master than the other books of the course, otherwise the library would fail to attract the children. None of the books should contain anything the children ought not to read, and none should be so difficult that they may not be read with pleasure and interest." The president is justly alarmed at the increase of near-sightedness with the advance of age in the school, the rate of which is shown to rise in Chicago from 4·09 per cent at six years of age in the Ogden School to 27·08 per cent at twenty years in the North Division High-School; but he can suggest no remedy except improved lighting and the most legible text-books. Concerning "practical education," a wholesome conservatism will serve as the sheet-anchor of safety. . . . The principal object of education is to instruct the pupil how to learn; to enable him to comprehend, in a way, the new things which encounter him when his school days are over. Up to this point, which, in the case of the child educated in the common school, will never be very high in an educational aspect, all the pupils should go, boys and girls alike. Drawing and book-keeping in its simple form might well be taught, for they are useful to every one. It is lamentable that nothing is taught, short of the high-school, concerning the organs and functions of the human body. A considerable portion of the work required of the pupils appears highly artificial, and of questionable utility. A tendency is observed to teach a mass of unimportant facts, which the pupils will certainly, and had better, forget, and a disposition to compel them to absorb and assimilate ideas beyond the ordinary comprehension of childhood. These things "may furnish an opportunity for precocity to shine, but do not facilitate the normal development of the intellectual powers." The practice of ascertaining the relative standing of pupils by the rapidity with which they answer questions, or perform certain operations, is highly un-

just and fallacious. "The standing of pupils should be established by the degree of thoroughness attained in their respective acquirements; that is the test of men in practical life, and it should be the same in school-life." The higher mathematics and the dead languages have received too much attention, because the fruits are of meager value and limited utility; but "more time should be spent in our schools in giving instruction in English words and expressions." The standard of English study should be raised everywhere.

Principles of Sea-Bathing.—Sea-bathing, when properly and carefully indulged in, is a most health-giving and enjoyable diversion. But a few broad principles should be remembered. Never bathe within two hours of a meal, never when overtired and exhausted, and never when overheated. At the same time the body should be warm, and not cold, when you plunge in. Do not remain in the water long enough to become tired or chilly, and when you come out dress quickly. It should also be remembered that bathing does not agree with everybody. Those who feel faint or giddy in the water, or whose hearts begin to beat overmuch, should consult a doctor who is thoroughly acquainted with their constitutions, before they enter the water again. Medical papers say that many of the bathing fatalities which have been generally attributed to "cramp" are really due to failure of the heart's action, induced by the plunge into cold water, and aggravated by swimming. A good result of the bath ought to make the bather feel warm and fresh. If, instead, shivering and cold ensue, harm is being done. Children should not be forced into sea-baths, for their reluctance may be occasioned by some constitutional drawback, testifying that the process is harmful to them.

The American Economic Association.—The American Economic Association has been founded by the co-operation of a number of students of that subject, for the encouragement of economic research, with the publication of monographs and the promotion of perfect freedom of discussion. It starts with the belief that political economy as a science is still in an early stage of its development; that its advance is to be sought through the historical and statistical study of actual conditions of economic life rather than through speculation. It recognizes that the conflict of labor and capital has brought into prominence a vast number of social problems, whose solution requires the united efforts, each in its own sphere, of church and the state. Without taking any partisan attitude in the study of the industrial and commercial policy of governments, it believes in a progressive development of economic conditions, which must be met by a corresponding development of legislative policy. Among the topics which are suggested as proper subjects for reports by the standing committees, are the employment of women in factories; municipal finance; rent in the United States; the National Railroad Commission; limitation of suffrage as a remedy for abuses in local administration; the effect of transportation on the laborer; and the silver question. The President of the Association is Dr. Francis A. Walker, of the Massachusetts Institute of Technology; the Secretary is Richard T. Ely, Ph. D., of Johns Hopkins University.

Parsee Funerals.—As soon as the case of a Parsee about to die is seen to be hopeless, he is washed all over in *gomez* (ox's urine), and dressed in clean clothes, while the priests repeat prayers and Avesta texts. When life is extinct, the feet are tied together, the hands are joined, and the body is laid on the ground-floor. A priest remains by it, saying prayers and burning sandal-wood, till the bearers come to take it to the *dakhma*, or "tower of silence." As soon as the bearers arrive, the seven parts of the Ahurian hymn are chanted, to combat the power of death, which has come from hell to seize the corpse and threaten the living. When this is over, the body is taken off by the bearers on an iron bier to the *dakhma*, where it is exposed, "clothed only with the light of heaven," to the vultures, which will strip it to the skeleton in about an hour. The skeletons soon become perfectly desiccated, and are then thrown into the deep central pit of the tower, where they crumble and are washed away by the

rains. The object of exposing the bodies in this way is said to be to avoid polluting the earth by burying them. Throughout the Zoroastrian writings that remain, this principle is continually dwelt upon. Cremation is even a greater crime than interment of the dead, because, it was alleged, of the exceeding holiness and purity of fire, which must not be polluted. These views, it has been suggested, originated in the abhorrence of primitive Zoroastrianism for cannibalism and human sacrifices, on account of which it surrounded the dead human body with such awful horrors and observances as should effectually defend it against them.

The Flying Force of Birds.—Dr. Karl Müllenhoff has published, in the proceedings of the German Society for the Advancement of Aëronautics, a paper on the force exerted by birds in flying. The latest calculations, by Marey and others, give the maximum force exerted by birds at 1·2 to 1·4 kilogramme per square centimetre of muscular section—numbers that are not greater, but rather less, than those which represent the strength of other animals. Dr. Müllenhoff deduces from his own calculations that the labor performed by the wing in any time-unit is little if any greater than that involved in walking on the ground. This result agrees with the facts shown by experiments that the weight of doves was not changed after considerable test-flights; and that it fell off only a few grammes after a flight of three or four hundred kilometres. Quite different from this are the results afforded by the experience, say, of velocipedists; one of whom confessed to the author that he had lost ten pounds after a few months of cycling, and who suffered after an hour or so of his exercise from a greatly quickened pulse and an intense heart-beating. Prechtl, of Vienna, some years ago published the conclusion that the force exerted by birds in changing their place was not greater than that of the other animals, and that the amount of force exerted by large and small birds was relatively the same. Helmholtz, twenty-seven years later, came to an opposite conclusion, which he based, however, only on theoretical grounds. He predicated a geometrical similarity in the forms and movements of smaller and larger animals, and that a greater increase in power must be given the larger animals to overcome the greater resistance they have to encounter. Dr. Müllenhoff having subjected this theory to an experimental test, has found it not sound. The geometrical similarity of motions does not exist. While the wings of the larger birds move up and down, those of the smaller birds move diagonally, and of the smallest nearly horizontally. The author having also examined the rate of increase of velocity corresponding with increase of size, separately as regards vertical and horizontal movements, finds that increase in the weight of the body is not accompanied by increase in the relative muscular mass; that the amount of absolute force does not increase as the bird becomes larger; that no differences are apparent between birds of different sizes in the velocities of the muscular contractions; and that, regarding differences in the quantity and quality of the food consumed by the larger and smaller birds—concerning which there is question—while the labor performed in flight can be furnished only at the expense of a corresponding consumption of chemical elasticity, we can so far not make any definite declaration concerning either the amount of substance consumed in flight-work, or the amount of food required to compensate for the substance that is consumed.

The Problem of the Irrawaddy.—Mr. Robert Gordon, who has recently addressed the Royal Geographical Society in support of his theory that the Irrawaddy is the outlet of the Sanpo of Thibet, says that that river presents the greatest geographical problem in Asia. Mr. Gordon's view is contradictory of the opinion generally held by geographers that the Sanpo is the Brahmapootra, a river that it must meet or run around before it can reach the Irrawaddy. In favor of his theory, he adduces the testimony of a number of Thibetan and Chinese authorities, dating from times of considerable antiquity; the size of the Irrawaddy in its upper course, which can not be supplied by the few small streams and the limited water-shed the geographers give it; the testimony of the names of various rivers and branches of rivers in

the debatable region; and the opinion of a number of geographers and travelers who do not agree with the majority. Moreover, the Brahmapootra does not need the Sanpo, and the Irrawaddy does. Mr. Gordon's views were strongly controverted by General J. T. Walker and other experts in Indo-Chinese geography.

Distribution of an Insect Species.—The *Anonia plexippus*, an American butterfly, is now engaged in distributing itself over the world. It is extending itself both eastwardly and westwardly. Its natural range appears to be from the Hudson Bay Territory to the Amazon and Bolivia; but some thirty or forty years ago it began to wander. It has established itself and become abundant in the Sandwich Islands. The first specimens were observed in the Marquesas Islands, by a Roman Catholic missionary, about 1860. It is now the commonest butterfly there. It has appeared in the Society, Cook, Harvey, Samoan, Friendly, and Feejee Islands, the North Island of New Zealand, Norfolk Island, Australia, Tasmania, the New Hebrides, Solomon Islands, New Guinea, Celebes, and Java; and it was abundant in New Caledonia a few years ago, but has become more rare there. In the eastward direction it has made its way to the West Indies, has been long established in Bermuda, furnished one specimen in the Azores in 1864, was found in South Wales in 1876, at La Vendée—the only specimen yet found on the Continent of Europe—in 1877, and in Kent in 1881.

Uses of Liquid Carbonic Acid.—The liquefaction of carbonic acid was at first a mere scientific curiosity, and only a few are probably as yet aware that it is much more. But a German firm, Messrs. Raydt & Kunheim, have devised an apparatus for producing the liquid, and are producing it in large quantities for industrial purposes. It is used for charging beer in the cask; and in the manufacture of seltzer-waters the gas is more easily and effectively introduced from a vessel containing the liquid than in the old-fashioned way. It has been found very valuable for the service of fire-extinguishers. The Krupps, of Essen, use it for producing compact castings. For this purpose the mold is closed as soon as the metal has been introduced, and is connected by a valve with the vessel containing the liquid acid, the pressure of the gas from which is augmented by heating it in a salt-water bath. The Krupps have found that a heat of 360° will give the colossal pressure of twelve hundred atmospheres. Another application of the liquid proposed by Dr. Raydt is to the raising of sunken ships by means of the gas from it. Compressed air has long been employed for this purpose, but it requires a costly apparatus that may be done away with if liquefied carbonic acid is substituted for it. In some experiments made at Kiel, a stone weighing three hundred quintals was raised, by means of a balloon filled with carbonic acid, from a depth of thirty feet to the surface of the water in eight minutes.

Travel by Balloon.—Mr. William Pole insists, in "Nature," that the feasibility of balloon navigation has been made very highly probable by the recent French experiments. M. Tissandier, in 1883, obtained with his dirigible balloon a velocity of nine miles an hour. The French military authorities then commissioned two of their officers, Messrs. Renard and Krebs, to work the problem further out. They obtained an independent velocity through the air of upward of thirteen miles an hour, with a balloon which was managed, steered, and guided with the greatest ease, and was made to return to its starting-point in defiance of the wind. Careful calculations, made according to the rules of M. Dupuy de Lôme and Professor Rankine, of the resistance afforded by the air and the efficiency of the screw-propeller, show that the attainment of considerably higher speeds is perfectly practicable. A balloon of fifty feet diameter, for example, would carry power sufficient to give a speed of upward of twenty miles an hour, and still leave a considerable buoyancy disposable.

Colors of Swedish Eyes.—Professor Wittrock read a paper before the Swedish Anthropological Society on the investigations into the hereditability of the color of the eyes, which he had undertaken at the instance of Professor Alphonse de Candolle. These results differed from those which

Professor de Candolle had published for Switzerland, North Germany, and Belgium. Brown eyes were more common among women than among men. From the fact that 56 per cent of the children of parents who were bi-colored (or one of whom had brown and the other blue eyes) had brown eyes, it appeared that eyes of that color were on the increase. The majority of wives had brown eyes. The average number of children of con-colored parents was 4·49, and that of bi-colored parents 4·03—contrary to Professor de Candolle's observations, which gave the larger number to bi-colored parents. It also appeared that 52·6 per cent of the children inherited the eyes of the father and 47·4 per cent those of the mother; of the sons, 51·8 per cent inherited the father's, and 48·2 per cent those of the mother, while the figures with regard to the daughters were respectively 53·5 and 46·5 per cent. These figures show that in Sweden the eyes are not predominantly inherited from the mother alone, and that the offspring of equally constituted parents should not be weaker than they. Children under ten years of age were excluded from the examinations, and blue-gray and gray eyes were classified as blue.

Causes of the Extinction of Species.—Professor A. S. Packard has published an article in the "American Naturalist" on some of the apparent causes of the "Geological Extinction of Species." He reviews at length the factors of changes of climate to which he ascribes the most extensive phenomena of the kind. In the palæozoic ages, the climate of the whole earth was nearly uniform, and species were very widely diffused. Upheavals of mountain-ranges and continental masses, taking place at different epochs, produced more or less marked differentiations and local conditions favorable to some species and unfavorable to others, with the result that some flourished while others declined and faded out. The glacial epoch, bringing great changes of climates, produced also many revolutions in the relations of species. Changes in altitudes, marked on the American Continent by the elevation of the Rocky Mountain and Andean districts to from five thousand to ten thousand feet, the workings of which are still going on to a certain extent, also materially affected those relations; and similar changes have occurred in the other quarters of the world. "The biological changes were not due to climatic and geological changes alone, but it should be borne in mind that the great changes, slowly induced, but not without striking final results, ending in the addition or loss of vast areas of land, induced extensive migrations, the incursions of prepotent types which exterminated the weaker. The reaction of one type of life upon another, the results of natural selection, were apparent all through; but these secondary factors were active both during periods of quiet and periods of change. . . . Local extinctions due to local changes of level; the formation of deserts, saline wastes, and volcanic eruptions and vast outpourings of lava, such as took place in Oregon and Idaho during the Tertiary, with submarine earthquakes causing the death of fishes on a vast scale, these are quite subordinate factors."

Toad-Lore.—Toads have much in common with frogs, but they are hatched from spawn that is deposited in long strings, while frog-spawn is in masses, and they have no teeth. They are also marked by ugly warts, which give out an acrid but not poisonous juice. They have tongues whose motions, nearly as quick as lightning, the eye can not follow, and which sweep in the insects they catch with such speed that the victims "seem to melt into thin air" rather than to be caught and swallowed. They can climb plastered and whitewashed walls or flights of steps, and even into flower-pots whose outward sloping sides would seem to forbid such an achievement. They will eat nothing that is not in motion except their own skins, which, when they are cast off, they roll up and swallow. The muscles of their thighs and legs strikingly resemble those of man. They can not breathe when their mouth is held open. The old necromancers used them freely and in various ways in their magic. In some parts of England the application of a toad is supposed to stop bleeding, and dried specimens are worn as charms against rheumatism. The members of a Devonshire family had a reputation for curing "king's

evil" by means of toads. Some of the German peasants are said to have a way of crucifying toads, which must be caught for the purpose on Easter-Sunday morning before sunrise; then burying them in an ant-hill, and leaving them there till Whitsunday, when their clean and white bones, worn in a little bag around the neck, will always make the possessor win in games of chance. The Thibetans, according to Abbé Huc, tell of a toad that dwells amid the mists of a lofty mountain-range, and, unless he is propitiated, flings ice and avalanches down upon those who pass in the valleys below.

Cuban Storms.—The "Meteorological Annual" of the Royal College of the Society of Jesus at Havana, for 1875, which has only recently been published, contains several instances of coincidences between Cuban storms and meteorological phenomena in the United States, and particularly of seeming relations with magnetic manifestations. During three days in April—3d, 4th, and 5th—a "norther" prevailed, and was succeeded on the three following days by a remarkable magnetic perturbation, which was accompanied with a high barometer and a strong wind, with daily manifestations of aurora in the United States, but without accompanying electric phenomena. A magnetic perturbation on the 13th of April was coincident with a norther, much thunder and lightning, a very heavy rainfall and a disposition and state of the aqueous vapor which gave rise to solar and lunar halos, and other optical effects; but during the time no auroras were reported from the United States. Father Viñes, the compiler of the "Annual," points out various other relations between the magnetical and meteorological phenomena which suggest that this line of inquiry is likely to lead to valuable additions to our knowledge of weather-changes. The diurnal and seasonal fluctuations of the barometric column in their varying amounts are significant in their relations to the analogous phenomena in the United States and over the high-pressure area of the Atlantic. For four days previous to the observation of the highest temperature of the year—July 30th, at 4 P. M., 98·8°—auroras had been observed in the United States, and the magnetic and electrical conditions showed marked disturbances at Havana. Of eighty recorded thunder-storms, sixty-five occurred during the five months from May to September, and only three during the four months from January to March, and December. This almost total absence of thunder-storms from the rains of the winter months, as compared with the summer months, when lightning or some other electric phenomenon occurs almost daily, is important in its bearing on the theory of the thunder-storm.

A New Species of Box-Wood.—A new species of box-wood has been discovered growing in the neighborhood of the Cape of Good Hope and in Caffraria, and a quantity of it has been sent to the English market. The first sample specimens that were sent were marred by defects in the grain, which made them of inferior quality for engraving purposes. A second and larger lot appears to promise better, for it is said of it that the logs are of good sizes, sound, and clean grown. The wood possesses a closeness equal to the best Abassian box-wood, and it is thought will suit admirably for engravers' purposes. It appears to be one of the best hard woods that has yet been put forward as a substitute for genuine box-wood. The new species very closely resembles *Buxus sempervirens*, and has been named *Buxus macowani*.

The Spectroscope and the Elements.—Professor Balfour Stewart, from an examination of the evidence afforded by the spectroscope as to the nature of the elements, concludes that it is, on the whole, in favor of their being in reality compound structures, the components of which possess attractions for each other vastly greater than those exhibited in ordinary chemical combinations. The fact that in the hottest stars we have the fewest atomic structures is also in favor of this hypothesis. Summing up the evidence derived from both terrestrial and celestial sources we have, first, experimental evidence of various kinds, tending to show that the so-called elements are not essentially different from other bodies; second, in the terrestrial spectrum of pure metals at a high temperature, certain lines are obtained for some one ele-

ment that are extremely near, if not coincident, in spectral position with those obtained for some other element or elements: these have been called basic lines; third, we know that in the sun's atmosphere there is a process at work tending to separate the various molecular and atomic structures, and we find that the greater number of the lines given out from the sun's hotter regions are basic lines, such as are above defined; fourth, in the very hottest stars, where the dissociation is greatest, we have only a few prominent lines given out, these being lines belonging to hydrogen, calcium, and magnesium. "I think," Professor Stewart adds, "we must conclude that the hypothesis that the elements are in reality compound bodies offers, with our present knowledge, a very good and simple explanation of the results of spectroscopic analysis in the earth, the sun, and the stars."

NOTES.

In Professor Jordan's sketch of Rafinesque, in the June number of the Monthly, page 216, "Hendersonville," Kentucky, should have been "Henderson." The correction was duly marked by the author, but failed to reach our press-room.

The thirty-fifth annual meeting of the American Association for the Advancement of Science will be held at Buffalo, New York, August 18th to 24th. Professor E. S. Morse, of Salem, Massachusetts, will be the president of the meeting. The Secretary of the Association is Professor F. W. Putnam, of Cambridge, Massachusetts.

The meeting of the British Association is to be held this year at Birmingham, under the presidency of Sir William Dawson. The sectional presidents will be: Section A (Mathematical and Physical Science), Professor G. H. Darwin; Section B (Chemistry), Mr. W. Crookes; Section C (Geology), Professor T. G. Bonney; Section D (Biology), Mr. W. Carruthers; Section E (Geography), Major-General Sir F. J. Goldsmid; Section F (Economic Science and Statistics), Mr. J. Biddulph Martin; Section G (Mechanical Science), Sir James N. Douglas; Section H (Anthropology), Sir George Campbell, M. P.

George Roberts, of Lofthouse, England, relates in "Science Gossip" that, having found two white slugs under some stones, he placed them on a green leaf, when they became in a few minutes of a greenish color.

In our notice of Mr. Seely's "Genesis of Inventions," in the May number of the Monthly, an error of the press made us give to the new branch of study which the author proposes the name of *Eunematics*, which has no significance, for *Eurematics*, the real name, which is a legitimate derivation from the Greek, and is appropriate.

The Committee of the American Ornithologists' Union, on the "Protection of North American Birds," seeks to gather and diffuse all possible information on the subjects of the destruction and the protection of North American birds, and the utility of birds; to encourage the formation of bird protective associations, and anti-bird-wearing leagues; to secure the perfection of suitable, practicable statutes in all the States and Territories for the protection of birds; to prevent the collecting of birds and eggs for pseudo-scientific purposes; and to consider the best means for securing the enforcement of bird-protective statutes. The headquarters of the committee are at the American Museum of Natural History, Central Park, New York city. Mr. George P. Sennett is its chairman, and Mr. Eugene P. Bicknell its secretary.

The Rev. Canon Charles Lett used to relate, in illustration of the reasoning power of the bird, that a gentleman in Waterford, Ireland, had, in 1828, a tame golden eagle, which was allowed the freedom of the yard and garden. The owner once, for amusement, placed the house-cat near the bird, which attempted to seize it and met the usual fate of too close assailants of cats. A chicken was next brought, and instantly pounced upon. The owner, however, released it, whereupon the eagle hopped clumsily after it, but could not overtake it. The bird then turned against its owner and attacked him with vigor, as if in revenge for being deprived of its prey.

Up to the middle of April, M. Pasteur had treated about seven hundred and fifty patients with his remedy for hydrophobia, with what is considered a very gratifying success. In some of the cases the patients may not really have received the virus, or the dog may not have been really mad; and six out of thirty-eight Russians who had been bitten by a rabid wolf died. But, when allowance is made for these, enough is left to give the seal of validity to the claims which the eminent practitioner sets forth for his remedy.

"Land and Water" publishes, and credits to a "local paper," a story told by a Scotch railway-laborer, who saw a hawk swoop upon a blackbird which was singing on a bush by the side of the river Ettrick. The blackbird, he says, was at once unperched and carried to the ground, strug-

gling and screaming in the talons of its adversary. The hawk, evidently finding considerable difficulty in dispatching the bird, dragged it along the ground to a shallow pool, where he put its head under the water and stood on it till his victim was drowned.

Dr. Riley, in his last entomological report, does not take a very hopeful view of the immediate prospects of silk-culture in the United States. In his opinion it requires a temporary stimulus, and he would suggest a duty on reeled silk imported from foreign countries. It is possible, however, that there are ways enough for Americans to make money without adding to the list of "protected" articles.

Professor W. Mattieu Williams disputes the validity of the recently published conclusion of a German philosopher, that accidents from lightning are increasing, and that the increase is owing to the multiplication of factories with their towering chimneys, and the consequent loading of the air with smoke, steam, and particles of dust. It does not agree with the accepted theory of lightning-conductors, that the multiplication of such agencies tends to the dissipation of atmospheric electricity and the rendering of it harmless. The real increase is not in the number of accidents, but in the regularity with which they are reported.

The King of the Belgians' prize of five thousand dollars, which was offered this year to the competition of the world for the best essay on "The Best Means of improving Sandy Coasts," has been awarded to M. de Mey, engineer, of Bruges, against fifty-nine competitors. The prize is alternately international and confined to Belgians. The subject for the next international competition is "The Progress of Electricity applied to Motive Power and Illumination: its Applications and Economical Advantages." The essays must be presented in French.

A correspondent of "Science Gossip" tells of a pair of swans which, having completed their nest on the bank of a dike, shortly proceeded, as if they were anticipating danger, to raise the structure two feet higher. On the next day a great storm occurred, with floods, that would surely have swept the nest away but for the precaution the birds had taken to secure it.

A French doctor, Sandras, claims to have discovered a way of producing extensive modifications of the voice—in vibration, force, and range—by the inhalation of different substances. Among the typical experiments which he exhibited recently before the Medical Society of the Pantheon, were extension of the register by the inhalation of Botot water; producing hoarseness and extinction of the voice with coal-tar; giving a drunken man's voice with alcohol; and by using other inhalants correcting the effects of cold in the head and of coal-tar inhalations.

OBITUARY NOTES.

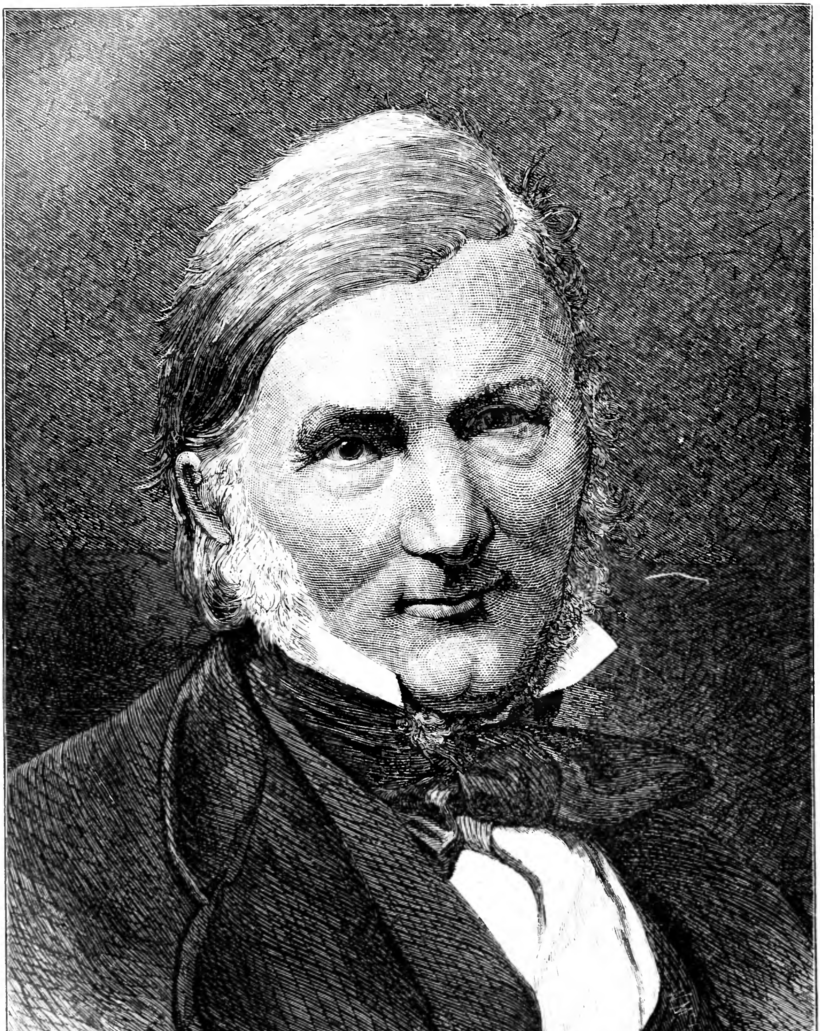
Dr. Edward Tuckerman, Professor of Botany in Amherst College, died March 15th, at the age of sixty-nine years. He was recognized as one of the leading lichenologists of the day, and as first in that branch on this continent.

Thomas Edwards, the self-taught naturalist of Banff, Scotland, died April 27th, in the seventy-fifth year of his age. His father was a hand-loom weaver, and he learned the shoemaker's trade. The passion for collecting dominated in him; and his devotion to science brought him considerable fame. He was elected a member of several learned societies in 1865, and afterward acted as Curator of the Banff Museum. He wrote many papers concerning his own discoveries for the scientific magazines. Mr. Smiles published a biography of him which made him generally known. This was followed by a subscription of £333 for relief in his old age, and the award by the Queen of a pension of £50 a year.

M. A. Lallemand, a distinguished French physicist, has just died at Poitiers, in the seventieth year of his age. He had served as Professor of Physics in several French colleges, and was for a number of years dean of the faculty at Poitiers. He was the author of important investigations on electro-dynamic action in the illumination of transparent bodies, and of researches in organic chemistry, among the results of which was the discovery of thymol.

M. Melsens, chemist, of Brussels, has recently died, in the seventy-second year of his age. He was the author of the discovery of iodide of potassium as an antidote for mercurial and lead poisoning.

Johann Georg Varrentrapp, one of the most distinguished and venerable hygienists of Germany, died at Frankfort, March 16th, in the seventy-eighth year of his age. He was for thirty years physician in the Heiligen Geist Hospital at Frankfort; he was one of the founders of the poor-clinic and of the medical society of Frankfort; he paid special and practical attention to questions of prison discipline and of school organization; he founded the special Section for Public Health in the Association of German Naturalists, and the German Association for Public Health. The "Berliner klinische Wochenschrift" mentions him as the earliest German sanitarian who considered the question of the cleansing of towns, and calls him the father of the practice of public health. In politics he was an active liberal.



OSWALD HEER.

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AUGUST, 1886.

WOODS AND THEIR DESTRUCTIVE FUNGI.

By P. H. DUDLEY, C. E.

I.

IN the forests which have contributed so much to the industries and wealth of the United States there are seventy species of trees which have been and are of great commercial importance, and three hundred and forty more species which have an economic value. But few countries have so great a variety.

A section from the trunk of a tree of nearly the entire list of the species, gathered from all parts of the United States, can now be seen in the great and valuable collection in the American Museum of Natural History of New York City, contributed by Mr. Morris K. Jesup. The difficulties attending such a great work, so as to show the appearance of the wood and size of the tree with its bark, can only be fully appreciated by those actually engaged in making the collection. The magnitude of the work is without precedent; and, while it has been possible to transport across the continent a section of a tree, it has not been possible to fully protect some of them from the attacks of fungi, and some species will have to be replaced, while others by seasoning have checked the ravages of their fungi, but they show discoloration of the wood. To many this is an objection, but, by showing what species easily decay, it enhances the economic value of the collection. So many of our primitive forests have been cut, that many species for general use are already consumed, and the importance of these specimens for study, in making selections for substitutes, can not be overestimated.

An inspection of the different species shows the marked diversity in the structure and appearance of the woods, and one is quickly relieved of the general impression that they are all alike. Examined microscopically, the differences in structure are sufficient for identifi-

cation of the species, and at the same time enable one to judge of the suitability of a particular wood for definite uses. So little has been done in this country in the microscopical study of the woods for engineering, architectural, or mechanical purposes, that but few are aware of the variety in form and structure of the wood cells, ducts, and special fibers which make up the woody tissue of the different species. An expert can readily determine whether a certain wood, used for railroad-ties, will sustain the service of a trunk line, or is only suitable for a branch of limited traffic.

In the *Coniferæ*, which includes the pines, cedars, larches, redwoods, spruces, and firs, as a rule, each layer of growth only has two kinds of wood-cells called tracheids, one of thin walls and a large lumen, and the other of thick walls and a small lumen; when the former predominates, making nearly all of the layer, the wood is generally soft, as in the white pine (*Pinus strobus*, L.), the cedars, redwoods, spruces, and firs. When the thick-walled cells form one fourth to one half of the layer, the wood is much harder, as in the long-leaf yellow pine (*Pinus palustris*, Mill), *Pinus mitis*, and the larches. On the thin-

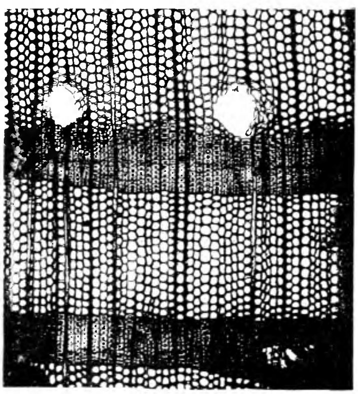

Fig. 1.—Transverse Section of *Pinus palustris* (Mill), $\frac{20}{1}$.

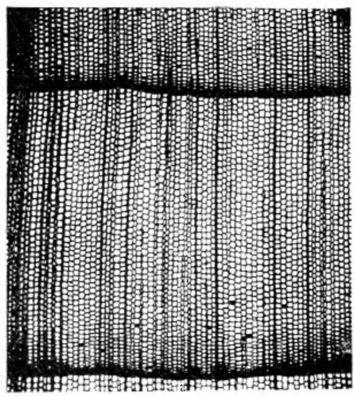

Fig 2.—Transverse Section of *Chamæcyparis sphærorda* (Spalch), $\frac{20}{1}$ (White Cedar).

walled cells of all the species of the *Coniferæ* are dome-like or lenticular markings, principally on the sides parallel to the medullary rays.

The thick-walled cells are often marked on the sides at right angles to the medullary rays. The *Coniferæ* have more or less resinous products, and the presence or absence of the upright resin-canals aid in distinguishing the genera, while the form and character of the medullary rays, the presence or absence of resin-ducts, the character of the cells, enable the species to be identified. In the alburnum or sap-wood, the starch is confined to the cells around the resin-canals and in the cells of the medullary rays.

The cellular structure of the oaks, chestnuts, hickories, ashes, walnuts, maples, beeches, birches, and magnolias is far more complex and

more highly differentiated than that of the conifers; beside the wood-cells, there are ducts, vessels, and special cells containing starch in the alburnum or sap-wood. In nearly all the species of the first five orders mentioned, the ducts grow in concentric rows, in the first of the season's growth; those which form later may be inclined through the layer of wood-cells, becoming smaller as they approach the outer portion. In the live oak, the ducts run radially through the ring, and the small fibers are nearly solid, giving the wood great hardness, making it so valuable for ship-building.

In the maples, beeches, birches, and magnolias the ducts are well interspersed through the entire ring, and are nearly of the same size. In the alburnum of these woods there are a great many cells which are filled with starch as reserve material, like the medullary rays in this portion of the wood. During active growth the starch is transformed and withdrawn. In the duramen but little starch remains, other products taking its place.

In the hard woods, all or portions of the annular rings are made up of hard and nearly solid fibers, while in the softer woods the walls are not so thick. In many of the species each layer of growth is not

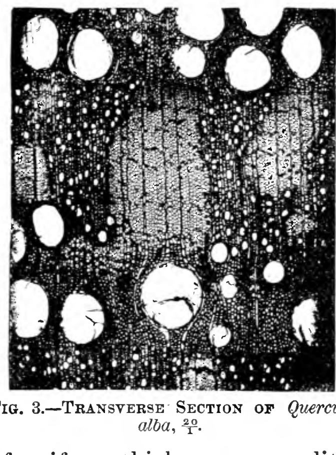

Fig. 3.—Transverse Section of *Quercus alba*, $\frac{20}{1}$.

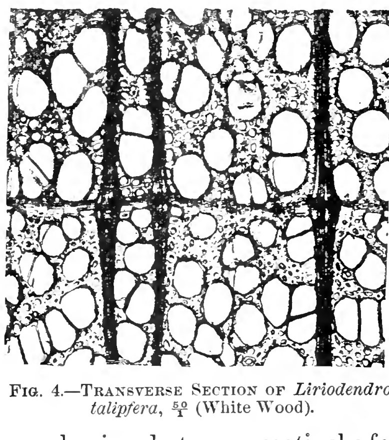

Fig. 4.—Transverse Section of *Liriodendron talipfera*, $\frac{50}{1}$ (White Wood).

of uniform thickness or quality, some having but comparatively few of the dense, hard fibers, the growth of these depending upon certain climatic conditions which may not yearly occur.

In the thick forests, under quite uniform conditions of growth, the thickness of the annular ring largely depends upon the leaf-area, which remaining practically the same in the older trees, the wood-cells forming upon a larger diameter, the rings as a rule are not so thick or dense as those grown when the tree is much younger.

Formerly, in lumbering, the trees were felled in the winter, cut into logs, sledded on the snow to the streams, and driven down in rafts in the spring to the mills. Now, with the log-railroads, they are independent of the snow, and in many camps lumbering is carried on

through the entire year. In the spring of 1876 I laid out a short log-railroad in the Michigan forests. The cut of the company for that year was 8,000,000 feet, board-measure; for 1886 it will be 120,000,-000 feet, largely to supply the Atlantic coast with white-pine lumber.

Timber cut in the spring growth, when the starch in the sap-wood is transforming, furnishes in this part of the wood a good media for the growth of various ferments which produce decomposition in such products, and unless quickly checked will start the decay of the woody tissue.

It was the universal belief, until a few years since, and is still a common one, that the decay of timber was due to *Eremacausis*—slow combustion. It is to the improvement and use of the microscope and its accessories, that the true causes of decay of wood are found to be due to various forms of fungi. Many definite forms which cause fermentation have been traced and more are known to exist which are beyond the definition of present microscopes, unless they can be stained so as to differentiate them. Photo-micrographs, which give indications of structure far beyond what the eye can recognize, are important aids in this study, while the details they give of the structure of the wood could not be obtained in any other manner.

What are the fungi?

A great group of a low order of leafless and flowerless plants, destitute of chlorophyl, many of them microscopic, whose functions are under certain conditions to break up and liberate the compounds of and in the cell-structure, formed by chlorophyl-bearing leaves in the sunlight.

In short, the functions of the growing fungi are to undo and return to the air and soil the elements assimilated by the higher plants and trees in their woody structure during growth.

A mycologist would give a different definition of the fungi having reference to the form of fructification and spores, their functions being of less importance to him; while an epicure would only describe the mushrooms which please his taste.

It is now estimated that over fifty thousand species of fungi have been described; less than five hundred of them were known in the beginning of the century. A great number of the species are confined to special habitats, and all of them will not be found upon the woods. One fungus may only be found upon one or two species of wood, while others will be more general. The species we illustrate by cuts belong to the highest orders, and are typical to some extent of many others. Associated with these are some of unicellular structure, which belong to the genus *Saccharomycetes*—or budding fungi—of which the yeast-plant is typical; and others belong to the *Schizomycetes*, the fission fungi—bacteria, etc.—forms of which are attracting so much attention in connection with diseases of mankind.

Generally speaking, the first condition by which the higher fungi

—illustrated here—can be detected is by their mycelia, consisting of filaments of, usually, white cells, branching repeatedly by lateral ramifications, growing at their apices, lacing and interlacing, forming in many places dense, felted masses. When they grow on the under side of a plank, closely packed boards, and railroad-ties, they are often similar in form to that shown in Fig. 5. So far as the decay of the wood is concerned, the mycelia of the fungi is the most important part. Though these filaments are small, ranging from 0·0004 to 0·002 of an inch in diameter, they are able to pierce the walls of the wood-cells when softened by moisture, which many of them seem to generate to aid in their destructive work.

The fungi, instead of propagating by visible seeds, only have microscopic spores, which are freely disseminated by the air to resting-places. When proper conditions for germination occur, the spore sends out a mycelium, which, by spreading over the under side of a plank, as seen in Fig. 5, induces, sooner or later, the decomposition of the structure of its host, to partly build up its own.

Where it has once run over the wood in a dense growth, it destroys its strength from one eighth to three fourths of an inch in depth, and if the wood dries, cracks and crumbles to pieces (see Fig. 5)—it forms the so-called "dry rot" in timber, which is said to take place when the wood is perfectly dry. This is a misconception, as it is impossible for decay to commence without moisture, sufficient heat and access of air to supply the amount of oxygen needed in the reduction of the tissue to lower compounds.

If the wood does not dry, the mycelia continues to grow until all of the wood-cells are disorganized and fall to pieces, or, in other words, completely rotted. In many cases, the mycelia works in the inner portions of the timber, as explained later, and does not show exteriorly until decay is well advanced ; this is especially true of larger timber.

"Dry rot" was named from the effect produced, and not the cause, to distinguish it from the so-called "wet rot." It has been an unfortunate designation, misleading many people, causing them to believe that timber will rot when dry, and proper precautions have not been taken to prevent decay, on the supposition that it would occur in any event.

The illustration in Fig. 5 is that of the mycelium of the *Polyporous radula* (? Fr.) spreading on the under side of the plank of station-platforms, which were destroyed in a year and a half to two years. It is typical of a large number of the mycelia of the fungi growing in similar conditions. One sees the same general appearance on lumber, plank, and sawed railroad-ties, which are piled together without being separated from each other by a small air-space. Hemlock inch boards can be completely rotted through in six to eight weeks of July and August weather, by the mycelia attacking both sides of the boards when damp, and piled up without an air-space between each. Cargoes

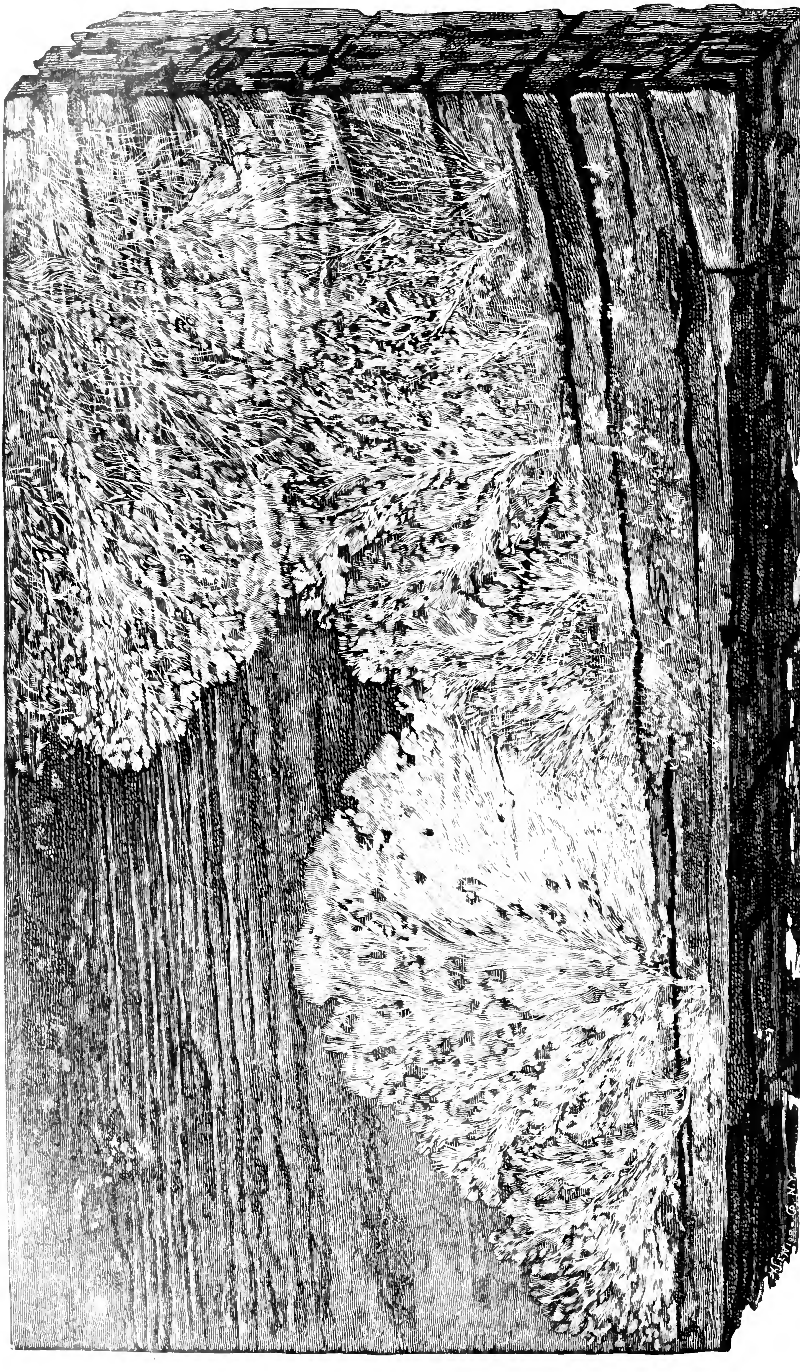

Fig. 5.—Mycelium of the Fungus, *Polyporus radula* (?) Fr.

of lumber and timber in long voyages are often badly injured by the growing mycelia between the pieces.

In bridges, ends of posts and struts, tenons and mortises, there are often similar growths of mycelia arising from the germination of spores by moisture, and decay eventually takes place. The illustration presented in Fig. 5 is one quite familiar to all who handle lumber and timber, but its import is not as generally understood as it should be, from the fact that such growths are thought to be due to the decay of the wood, instead of being the inducing cause.

A little more care in piling and stacking green lumber by producers and consumers, permitting circulation of air between each piece, would prevent the growth of various mycelia, and save annually large quantities of lumber.

If moisture collects and remains on seasoned timber, the mycelia will also grow and destroy it. Large timber should be seasoned under sheds, otherwise the sun will season an outside layer, preventing the escape of moisture, and internal growths of ferments and mycelia-fungi will destroy the inside of the timber, a thin outer shell remaining sound for some time.

The illustration is one of the most important that can be presented. It shows the destruction induced by the growing mycelium on the wood. On the right and lower edges, where the growth first appeared, it has caused the wood to crack not only with the fibers, but across, and in a short time longer it would have fallen to pieces, as portions of adjacent planks had some time previously.

The form of fructification of the fungus of mycelium shown in Fig. 5, as found, was *resupinate*, attached to the under side of the plank as that shown in Fig. 6, which is a species of *Polyporous* very destructive to hemlock in inclosed warm and damp places.

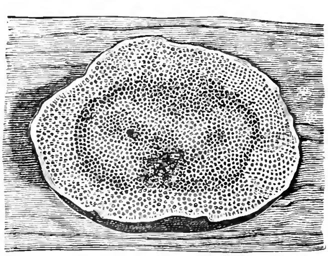

Fig. 6.

Resupinate forms of the *Polyporei* are very common on the under side of boards and timbers they are destroying, covering irregular areas; some will be ten by four inches, others follow along the edge of a board adjacent to a wall, ten to twenty inches, having an irregular width of one to two inches, the pores always pointing downward. A definite contour not being followed, identification of the species is often very difficult.

Fig. 7 shows the under and upper sides of the fruit of the fungus *Lentinus lepideus* (Fr.)—"Scaly Lentinus"—an agaric, and in this immediate territory is the one so destructive to timber of yellow or Georgia pine (*Pinus palustris*, Mill) in bridges, docks, and railroad-ties.

I have also found it upon the timber of *Pinus mitis*. Being the first

to call attention to its destructive influence, its brief technical description will not be out of place: "Pileus fleshy, firm, convex, or expanded, nearly white, spotted with dark brown, appressed scales; lamellæ rather broad, not crowded, attached, slightly emarginate, and decurrent, white, the edge rough, eroded or torn, stipe firm, solid, equal or

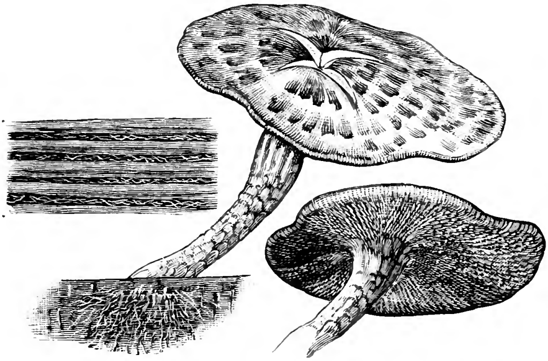

FIG. 7.—*Lentinus lepideus* (Fr.), one half size.

tapering downward, more or less scaly, whitish, sometimes eccentric, straight, or curved. Height, two to four inches; breadth of pileus, three to five inches; stipe, one half to three fourths of an inch thick."

Monstrous forms occur in dark situations with or without a pileus. Only a single stipe and pileus are here shown as emerging from a crevice in the wood; generally two, and sometimes four occur. The small block in Fig. 7 shows the mycelium in the longitudinal resin-ducts (see Fig. 1), which it readily pierces, hastening the destruction of the wood.

On the gills or lamellæ are borne the spores, which are 0·003 of an inch long, and 0·0013 of an inch in diameter, they are curved and one end apiculated; drop out and are carried by the wind to some resting-place; and when the proper conditions occur, germinate, sending out the mycelium, which only fruiting under very favorable conditions from June to September, the fruit is rarely found. I have seen many thousand ties in main tracks destroyed by it, without finding a specimen of the fruit; its mycelium is very abundant, and pierces the coarser cells of the wood with great rapidity, generating sufficient moisture, having an acid reaction, to carry on its destructive work, provided external heat and currents of air are not sufficient to dry the wood.

Examining many pieces of bridge-timber of *Pinus palustris* (Mill), which were horizontal, I found that where they had rested on others, sufficient moisture had collected to germinate the spores, and the mycelia had followed the longitudinal cells each way, meeting in the center, between the supports; the outer portions of the timber remaining dry, did not allow the moisture to escape, and the fungus was destroying the inside, while the outside looked sound. In bridge-plank the

moisture accumulated where it rested on the joists, the mycelia working upward and each way, usually leaving a thin portion of one eighth to one fourth of an inch in thickness, on the under side of the plank, where exposed to the air, giving the appearance that it was all sound. The abundant fructification during a brief warm rain in September, 1883, was the first indication of the destruction which had taken place.

The upright cells or tracheids composing the annular ring of the *Pinus palistris* (Mill) are of two kinds—one of thin and the other of thick walls ; the former fill the inner part of the ring, the latter the outer portion, giving the great strength and hardness characteristic of this wood ; interspersed through the ring are a few resin-ducts. In decay induced by its special fungus, the mycelium often separates some of the annual layers, and in most cases the thin-walled cells are first softened. Driving spikes into railroad-ties of this wood breaks and loosens the layers, and facilitates the entrance of the mycelium, and then larvæ, from one sixteenth to one eighth of an inch in length, eat and bore in the large softened tracheids, leaving the harder ones, so that in ties of four to seven years' service we often find little more than a series of nearly separated shells. The mycelium of this fungus once in a road-bed lives for some time, and in summer is ready to attack new ties of this timber as soon as put in the ground. I have noticed ties taken up, after a short service of six to eight months, which were covered on the bottom by the branching mycelium, and after drying one eighth to one fourth of an inch in depth would crumble to dust. It takes much longer for the mycelium to destroy the heart-wood of the yellow-pine sleepers from the bottom and sides than when it has access to the ends. In the first case it must nearly destroy the small medullary cells to reach the various rings, while from the end it has a larger area of the rings, which it readily follows. Painting the ends of this timber offers but little protection if the slightest opening occurs, as a spore can enter, grow, and carry on its destruction for a long time before it shows exterior decay.

The mycelium of *Lentinus lepideus* (Fr.) is composed of small branching filaments, only measuring 0·0004 of an inch to 0·0008 of an inch in diameter. With it I generally find an abundance of crystals of one form of oxalate of lime, and many cells of other fungi in adherent masses. The destructive power of this fungus is very great, and is causing enormous losses to consumers of the yellow pine, which are not realized or even suspected. In the sap-wood of this timber the fungus *Sphæria pilifera* (Fr.) readily grows, piercing the resin-ducts in the medullary rays, its hyphæ spreading to the upright resin-canals, and, from its abundance and dark color, discolors this portion of the wood ; which, if it remains damp and warm, the fermentation set up soon destroys the sap-wood. This fungus grows at a very low temperature, and is very destructive.

In new railroad-ties of yellow pine, which came from Georgia

February, 1886, for the use of New York roads, the sap-wood was already discolored, and some new growths of *Sphæria* took place here in March. Initial decay has already commenced in those ties, which will be facilitated by the conditions occurring when they are placed in the road-bed.

Fig. 8 is that of *Polyporous versicolor* (Fr.), which is very common and abundant, and is attached by its margin to the wood so that its form is called *dimidiate*. Several caps usually project one over the other, the lowest being the longest, each succeeding one above being shorter. On the under surface of each cap are the pores just visible to the eye, which bear the spores. The distinct colored bands or zones upon the upper surface give it a beautiful effect, as seen upon the wood it is destroying. It is easily found, as its substance is quite tough and dries before the insects and molds destroy it. It is generally abundant upon the sap-wood of white-oak piles, especially if the bark is left on after felling. It grows on the sap-wood of the white and red oak and chestnut ties; also upon the sap-wood of chestnut posts, and on the sap-wood and heart-wood of wild-cherry. As a rule, I found it more abundant on sap-wood of the oak than on chestnut ties. My observations refer to the entire length of the Boston and Albany Railroad, and many other roads in New England. The bark should be removed from piles and ties of the woods just mentioned, as it allows them to season and dry, checking the growth of this fungus; whether it is alone capable of destroying the heart-wood of chestnut ties has not been ascertained. I never found it growing there, but, instead, *Fistulina hepatica*—*Agaricus Americanus* (Pk.), *Polyporus pergamenus* (Fr.), *Dædalea quercina* (P.), and *Polyporus hirsutus* (Fr.), the latter being very abundant in old chestnut ties put in a temporary embankment at Worcester, Massachusetts. It was also abundant in the chestnut curbing of some of the unused hydrants.

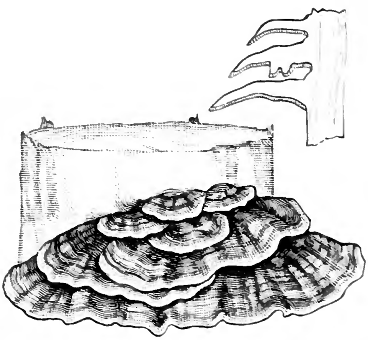

Fig. 8.—*Polyporous versicolor* (Fr.).

The heart-wood of chestnut ties is not so quickly attacked by fungi as some other woods, most of them being removed on account of the mechanical destruction of the fibers under the rails before decay takes place. I have several specimens of mycelia in the heart-wood of chestnut ties, but have only found a few developed efforts of fructification.

Polyporous applanatus (Fr.) is frequently found upon the sap-wood of many oaks, and is the one I generally find upon the heart-wood of

white-oak ties. It is usually *dimidiate*, as shown in Fig. 9, though, when growing upon the under side of timber above-ground, it is often resupinate ; the pores all point downward, the substance of the cap is hard, and, if undisturbed, the pores in the next year's growth form over that of the preceding years, but, enlarging the area, many of them are found twelve to eighteen inches across, and by cutting through them so as to show the section, six to eight years' growth is often seen. In this figure but one year's growth has taken place ; frequently two caps form instead of only one, as here shown.

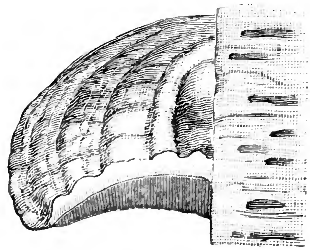

Fig. 9.—*Polyporous applanatus* (Fr.).

In white-oak timber and ties the earlier growth of the mycelium is not as continuous and uninterrupted as in the yellow pine, but grows more in little white patches, with considerable wood intervening between each. In Fig. 9 they are shown as dark spots. The massive bundles of medullary rays of this wood slowly decay, and preserve their form long after the other tissue has decayed. The large ducts seen in Fig. 3 are not open with a free communication, but filled with a delicate tissue, remains of which are visible in the cut ; this tissue will be found quite perfect in ties well advanced in decay.

The fungi so far illustrated in this paper apply mostly to the decay of timber under conditions similar to those of railroad service. In the next paper I shall give two or three illustrations of fungi of more general character. To deal with the great practical question of preventing wood from decay, the subject requires a more special treatment than it has received. Each species of tree, to a great extent, has special fungi, as it has insects which are not common upon other kinds of wood. Red cedar, cypress, locust, and catalpa are very durable in contact with the ground, where some others would quickly decay. The chemical composition of woods is not practically the same, as recently stated, but differs even in the sap- and heart-wood of the same species. Some of the woods have compounds in their cells easily induced to decompose and start the wood-tissue, while others have different compounds requiring inducing agents of greater intensities to begin decay ; and it is not true that a fungus which will destroy one wood will destroy all of the other species, and this one fact is of great practical importance, for, in a road-bed filled with the mycelium of one kind of decayed wood, another wood may be used which is not affected by that fungus, and its mycelium would be inert.

In treating wood it is found that the chemical which will prevent the germination of the spore of the fungus may not protect it from the attacks of its mycelium, contained in the ground or upon other decayed timber.

Experience has long since established the fact that wood kept per-

fectly dry will last for many hundreds of years, as has been the case in the roofs of foreign buildings, or when it is submerged in the water, as has been the case of piles used for foundations of the earlier bridges in older countries. Posts and telegraph-poles can daily be seen which are decaying near the ground-line, but sound above, after three to four years' service. By comparing the different conditions of use, it can be seen how little change is required to render unstable what would be stable under other circumstances. In roofs, the conditions are dryness, circulation of air, plenty of spores, and sufficient temperature to germinate, but the necessary moisture is absent. In the case of submerged piles, plenty of water, sufficient temperature, but exclusion of air, either to carry spores or permit them to grow. In the case of the posts and telegraph-poles we have the spores, the moisture, and the necessary temperature in summer for germination, and decay ensues from the fact that these are the essential conditions for the growth of the fungi whose work it is to undo and liberate the compounds in the woody tissue.

AN ECONOMIC STUDY OF MEXICO.

By Hon. DAVID A. WELLS.

V.

Present and Future Relations of the United States to Mexico.—The relations of the United States to Mexico naturally group themselves under two heads—political and commercial.

The political relations of the United States with Mexico, whether the people or the Government of the former wish it or not, are going to be intimate and complex in the future. The United States is geographically married to Mexico, and there can be no divorce between the parties. Intercommunication between the two countries, which a few years ago was very difficult, is now comparatively easy, and facilities for the same are rapidly increasing. And with the rapid increase of population in the United States, and with increased facilities for travel, the number of people—restless, adventurous, speculative, or otherwise minded—who are certain to cross the borders into Mexico for all purposes, good and bad, is likely to rapidly increase in the future. An extensive strip of territory within the Mexican frontier is already dominated, to a great extent, for the purposes of contraband trade, by a class of men who acknowledge no allegiance to any government, and whom the Mexican authorities tacitly admit they can not restrain. Out of such a condition of things political complications between the two countries, at no distant day, are almost certain to arise.

Again, in asserting the "Monroe doctrine," the United States virtually assumes a protectorate over Mexico. For, whatever else the Monroe doctrine may embody, it unmistakably says to Mexico: "You shall not change your form of government"; "You shall not enter into any European alliances"; "You shall not make cessions of territory, except as we (the United States) shall approve"; and in return "We will not allow any foreign power, ourselves excepted, to bully, invade, or subjugate you." It may be, and is, replied that the necessity of repelling from the outset any attempt at further aggrandizement of any European power on the North American Continent, with its contingent menace to the maintenance of democratic institutions, sufficiently justifies the assertion of the Monroe doctrine, and is for the good of Mexico as well as of the United States. But, at the same time, if there was any other power on the American Continent which should arrogate to itself the right to dictate to or control the United States, as the United States arrogates to itself the right to dictate to or control Mexico, and had sufficiency of power to make its assumptions respectable, could there be any doubt that the people of the Federal Union would regard such pretensions as a justifiable occasion for hostile protest and defiance?

Every right, however, carries with it and involves a duty; and the assertion of the Monroe doctrine by the United States carries with it an obligation of duty in respect to Mexico. What is that duty? Manifestly the duty which the strong owes to the weak. Not an offensive protectorate or meddlesome interference, but a kindly feeling and policy; manifesting itself in acts that will tend to promote the prosperity of our neighbor, and bring her willingly in accord with our own interests and wishes. Has that kindly feeling ever been manifested? To answer this question intelligently, one needs but to get a position outside of ourselves—more especially anywhere among the other people and states of the American Continent, north or south of our boundaries—when a little inquiry will satisfy, that the United States is regarded very much in the light of a great, overgrown, immensely powerful "bully," from whom no favor and scant justice are to be expected under any circumstances; and who would never hesitate, if interest or selfish indifference prompted, to remorselessly trample down—in the old Anglo-Saxon spirit (and as it always has)—any weaker or inferior race, Mexicans, Indians, or Chinese, the poor fishermen of Newfoundland, or again the negro, if political sentiment in respect to the latter was not running for the time being in another direction. And it is safe to say that to-day there is not a nation or people on the face of the globe, which is brought in intimate contact with us, but fears and hates us; and that, apart from a conservation of the principle of free government, which the United States is believed to typify, would not be glad if the power of the Federal Government were by some contingency to be impaired or destroyed. Is it not

time, therefore, that some steps should be taken to induce a different and a better state of feeling?

But, apart from any moral or ethical view of the situation, an exceptional, kindly treatment of Mexico ought to be a permanent national policy on the part of the United States, for reasons purely of self-interest, apart from any other motives. What Mexico most needs and what she has never had, unless the present Administration be an exception, is a stable, good government. Without such a government the large interests which citizens of the United States are acquiring in Mexico are sure to be imperiled. Some eighty million dollars of American capital are understood to be already represented in Mexican railway constructions; and other large investments have undoubtedly been made in mining and "ranching" in the country. Now, if history is to repeat itself, and there are to be further domestic revolutions and intestine strife in Mexico, and these American property interests or their owners are, as a consequence, to be arbitrarily or unjustly treated—i. e., in the way of confiscations, or forced contributions—resistance will follow; claims for damages will be created and pressed; national intervention will be sought for, and, in the present temper of the American people, will probably be granted—with a possible sequence of war and annexation. Certainly the last thing which the United States would be likely to tolerate, would be political chaos, with involved American interests, across its southern border. If it be said that there is no danger of this, it should be remembered that the present President of Mexico came to his office for the first time in 1876, through successful rebellion against the regularly elected authorities; during which period the Vera Cruz Railroad was destroyed at different points by the revolutionists, and all travel throughout the country greatly interrupted and made dangerous; and also that during the last twelve months there have been incipient rebellions against the central authorities.

But good government in Mexico is a matter not easy of attainment. There can be no good government in any country without good finance, and the finances of Mexico are always in an embarrassed condition; and this almost necessarily for a variety of reasons. In the first place, as already pointed out, the extreme poverty of the masses, the absence of accumulated wealth, the sluggishness of all societary movements, the practical exemption of land from taxation, and the adoption of a method of taxation that blights the harvest that it is desired to gather, all render the collection of an adequate annual revenue very difficult. Owing to the semi-civilized condition of its people, Mexico is necessarily obliged to support an army nearly double that of the United States (45,323 rank and file in 1883), to maintain anything like a permanent government; and the expenditure which this military establishment entails absorbs about one third part of the total revenue of the state, as compared with a present *direct* military ex-

penditure on the part of the United States, of not more than one tenth of its annual receipts.*

In a certain sense this large expenditure on the part of Mexico is for the direct benefit of the United States; for, if Mexico did not maintain reasonable peace and order throughout its great territory, the United States, having regard simply to its own peace and interests, would have to do it through military rule, on certainly so much of Mexico as is contiguous to the Federal dominions.

There can be no doubt, further, that there is a powerful party in Mexico—the old social leaders, and what considers itself the best society of the country—embracing the Church, the notables, and persons of wealth and ancient lineage allied with Spain—which is not at all in sympathy with the younger and progressive element of the nation, and sullenly opposes the introduction of railroads, and dislikes the United States. And this party would, if it could, dominate the policy of the country in all political and commercial questions. In proof and illustration of this, note the following extract from a recent article in the "Voz de Méjico" ("Voice of Mexico"), an able Catholic daily published in the city of Mexico, against the policy of admitting American capitalists into the republic:

> "We combat," it says, "the policy of liberalism, which, greedy of material prosperity, and dazzled by the brilliancy of North American progress, opens freely the doors of our frontier to the capital of our neighbors. We do not oppose material progress, but we rather desire that it should come by natural steps, in proportion as the peace and public guarantees re-establish confidence and encourage the development of the country's own resources. Without foreign capital and without foreign labor, nothing or very little shall we be able to do, but we ought to refrain from calling in our neighbors, whose tendencies toward absorption are well known, in order that they shall decorate luxuriously our house and then install themselves in it definitely, relegating to us the departments of servitude. Prudent patriotism and good sense advise, therefore, that the co-operation of the Americans be dispensed with, although it be at the cost of material progress."

On the other hand, the present Government of Mexico seems to be cultivating and encouraging every effort, that may serve to strengthen society against the possibility of any conservative reaction.

Thus, the attitude of the Government toward the various Protestant sects, which are earnestly striving to gain a foothold in Mexico and extend their special theological views among its people, is well illustrated by the following answer which was returned some time since by the Governor of one of the important States of Mexico to a Protestant clergyman, who had made application for military protection for his church, against a threatened mob:

* The maximum military force of the United States allowed under existing laws is 2,155 commissioned officers and 25,000 enlisted men. The estimated cost of the military establishment of the United States for the current fiscal year, 1886–'87, exclusive of expenditures for public works, is $25,680,495.

"Sir, I willingly give you the desired protection, as it is my duty to see that the laws are respected; and, while I feel no interest whatever in your religious forms or opinions, we are all interested in encouraging the organization of a body of clergy strong enough to keep the old Church in check."

Whether the Catholic Church will accommodate itself to the new order of things, and be content to live peaceably side by side with civil liberty and full religious toleration, is yet to be determined. Ex-Consul Strother, who has already been often quoted as an authority, thus graphically exhibits the respective attitudes of the former and still great ecclesiastical power and its acknowledged antagonist, the Government: "They may be illustrated," he says, "by a glance at the Grand Plaza of the city, across an angle of which the palace of the liberal Government and the old cathedral stand looking askance at each other. On the one hand, at the guard-mounting, the serried lines of bayonets and the rolling drums appear as a daily reiterated menace and warning. On the other, we might naturally expect to hear from the cathedral towers a responsive peal of indignant protest and sullen defiance. Yet we remember that it is not the clergy, but the Government, which holds the bell-ropes."

Now, why should not the United States, which heretofore has been so prompt to sympathize with and even give material aid to the people of every Old World nationality struggling for freedom and against oppression—to Poland, Greece, Hungary, and Ireland—be equally ready to sympathize with and help the progressive party of Mexico, in the efforts they are unquestionably making to put their country in accord with the demands of a larger civilization?

But, assuming the general concurrence, on the part of the people of the United States, in the proposition that an exceptionally kindly treatment of Mexico ought to be a permanent policy of their Government, such a proposition, even if proclaimed in a joint resolution of both Houses of Congress, would be little other than an expression of sentiment, unless accompanied by practical action. But, through what measures, having this definite end in view, it may be asked, can practical action, not repugnant to the spirit of the Constitution or the precedents and traditions of the Government of the United States, be instituted? And, in answer, the following points are submitted for consideration:

First. That the Government and people of the United States should do all that can be reasonably asked of them to dispel the idea or suspicion, that now prevails throughout Mexico and all Central America, that the North Americans desire and intend, at no distant day, to take possession of all these countries, and destroy their present nationality. So long as this suspicion exists, the influence of the United States in Mexico and Central America, will be based to a great degree on apprehension, rather than liking. A return of the cannon and flags capt-

ured by the armies of the United States in the War of 1847, as heretofore proposed, would undoubtedly greatly contribute to dispel this feeling ; but, apart from this, would it not be well for those who are especially anxious to send the gospel to the heathen, to consider whether it conduces to a higher life and civilization, for two neighboring nations to live on a basis, which, if made applicable to individual members of the same community, would be regarded as akin to barbarism ? *

Second. The public debt of Mexico, which is recognized as valid, is estimated at about $90,000,000, and the obligations which it entails constitute a serious embarrassment to the Government, and a heavy burden upon the resources of the country. Numerous attempts have been made to fund it, with adequate provision for the payment of interest—the payment of the principal being regarded as hopeless ; but all efforts thus far have practically amounted to nothing—a scheme by President Gonzales in 1884 for a new conversion, by the issue of bonds to the amount of $86,000,000, having well-nigh occasioned a revolution ; not that Mexico wanted to repudiate, but because the whole measure was believed to be tainted with fraud. And yet it stands to reason that, so long as this debt remains unsettled, unsecured, and its interest regularly in default, Mexico, as a nation, can expect but little credit, no sound finance, and no sound government. And, imperative as is the problem, there seems but little present chance for Mexico to solve it. The United States could, however, easily accomplish it. With its interest guaranteed, the Mexican debt could undoubtedly be funded at from two to two and a half per cent interest, involving an annual charge, say, from $1,800,000 to $2,-225,000—less than what is almost annually wasted on river and harbor improvements that subserve only private interests ; and not much more than the four leading railroads of the Northwest have this year (1886) decided to add to their annual interest charges, for the purpose of extended constructions over territory that can at present return but little remunerative business. Is it a sum too great for the American people to pay, if it will help to give good government to a contiguous territory nearly as large as all of the United States east of the Mississippi?

That such a proposition is likely to be scouted, in the first instance, by the American public is to be anticipated. "Have we not debts enough of our own to pay," it may be asked, "without looking

* In 1878, Hon. John T. Morgan, United States Senator from Alabama, recognizing the importance of this matter, and after thus expressing himself in a speech—"Mexico is not destitute of a cause to look with jealous eye upon the people of the United States, while we on our part have the greatest reasons for treating her with a generous and magnanimous spirit"—proposed "that the United States should solemnly covenant, not to change the present limits of Mexico, nor to consent to their being changed by any other nation." The proposition, however, did not attract any attention, or lead to any official action.

after those of other people?" But let us reason a little. Can it be doubted that, after the termination of our late civil war, the United States would have practically enforced against the Maximilian government, had it been necessary, that phase of the Monroe doctrine, which affirms that European political jurisdiction shall not be enlarged on this continent? Fortunately, Mexico was able, out of its patriotism and sacrifice, to protect itself against the encroachment of foreign powers; and thus saved the United States from a conflict, that would have permanently increased the burden of its debt, by many times two million dollars.

Again, the demands of the world's commerce, for the establishment of speedy and cheap methods of transit across the narrow belt of Southern Mexico and Central America which separates the two oceans, are being recognized; and new routes supplying such conditions, at no distant day, are certain to be established. European sovereignty over them is, however, repugnant to the sentiment of the United States, and, if attempted, will probably be contested; and this, in turn, if anything more than words of protest are to be used, means formidable military and naval demonstrations and large expenditures. The people of the United States might, however, well hesitate before embarking in such an enterprise, in view of the fact that the foe which their forces would have to especially encounter and most dread, would be one against which neither courage nor skill would avail; for over all the low, tropical regions of Central America, where the routes for interoceanic transit have got to be constructed, the climate for unacclimated persons is most deadly—in proof of which the current mortality of Vera Cruz, San Blas, and the line of the Panama Canal may be cited; as well as the horrible historical experience of the forces, which the North American colonies sent in 1741 to co-operate with Admiral Vernon's expedition to Carthagena and the coasts of "Darien" (Panama). But Mexico is a nation of soldiers; and, if proper kindly relations were to be established between the two countries, the United States could confidently rely on, or employ the well-acclimated troops of the former, to guard any transit routes from foreign appropriation and control; even if a desire on the part of the people of Mexico and Central America to preserve the integrity of their own territories, was not sufficient to prompt them to defensive action. But kindly relations, between nations, are not to be established in a day and under the pressure of a one-sided necessity; and nations, as well as men, "gain doubly when they make foes friends."

Third. The commercial relations of the United States with Mexico are, to all intents and purposes, comprised in and identical with the system of railroads which American capital and enterprise have introduced into the latter country. Their introduction has constituted the last and the greatest revolution that Mexico has experienced since the achievement of her independence; for, with the means which they

have for the first time afforded the central Government for quick and ready communication between the remote portions of the republic, a stable government and a discontinuance of internal revolts and disturbances have for the first time become possible. Thus, to illustrate: Chihuahua, an important center of population, is distant a thousand miles or more from the city of Mexico; and between the two places, in addition, a somewhat formidable desert intervenes, of about a hundred miles in width, and over which the Mexican Central Railroad trains are obliged to carry a water-supply for their locomotives. Previous to 1883, if a revolution broke out in Chihuahua, the most ready method of communicating intelligence of the same to the central Government would have been to send a man on foot, probably an Indian runner. If the messenger averaged fifty miles a day, twenty days would have been consumed in reaching the city of Mexico, and from three to six weeks more at the very least, would have been required to dispatch a corps of trained soldiers from the capital, or some intermediate point, to the scene of the disturbance. But before this the revolutionists would have had all the opportunity for levying forced loans or direct plunder, or the gratification of private animosities, that their hearts could desire. And it is altogether probable that, in a majority of such cases, political grievances were merely alleged as a pretext for and a defense of plunder ; and it is a wonder how, under such circumstances, there could be any desire for or expectation of accumulation through production, and that universal barbarism did not prevail. But now, under the railroad and its accompanying telegraph system, if anybody makes a *pronunciamiento* at Chihuahua, the Executive at the city of Mexico knows all the particulars immediately ; within a few days a trained regiment or battalion is on the spot, and all concerned are so summarily treated, that it is safe to say that another similar lesson will not soon be required in that locality. The new railroad constructions were, therefore, absolutely essential to Mexico as a condition for a healthy national life, and the country could well afford to make great sacrifices to obtain and extend them, apart from any considerations affecting trade development.

But the American railroads in Mexico have, in addition, already done much to arouse the most stubbornly conservative people on the face of the globe from their lethargy, and in a manner that no other instrumentality probably could have effected. When the locomotive first appeared, it is said that the people of whole villages fled affrighted from their habitations, or organized processions with religious emblems and holy water, to exorcise and repel the monster. During the first year of the experience of the Mexican Central, armed guards also were considered an essential accompaniment of every train, as had been the case on the Vera Cruz Railroad since its opening in 1873. But all this is now a matter of the past ; and so impressed is the Government with the importance of keeping its railroad system safe and intact, that the Mexi-

can Congress recently decreed instant execution, without any formal trial, to any one caught in the act of wrecking or robbing a train. That any improved methods of intercommunication between different people or countries—common roads, vessels, railroads, or vehicles, or the like—increase the production and exchange of commodities, is accepted as an economic axiom. But there could be no more striking and practical illustration of this law, than a little recent experience on the line of the Mexican National Railroad. The corn-crop, which is the main reliance of the people living along the present southern extension of this road for food, had for several years prior to 1885 failed by reason of drought; and, under ordinary circumstances, great suffering through starvation would inevitably have ensued. The natives, however, soon learned that with the railroad had come a ready market, at from two and a half to three cents per pound, for the fiber known as "*ixtle*"; the product of a species of agave, which grows in great abundance in the mountainous regions of their section of country, and which has recently come into extensive use in Europe and the United States for the manufacture of brushes, ladies' corsets, mats, cordage, etc. And so well have they improved their knowledge and opportunities, that the quantity of ixtle transported by the Mexican National Railroad has risen from 224,788 pounds in 1882 to 700,341 in 1883; to 3,498,407 in 1884; and 3,531,195 in the first seven months of 1885; while with the money proceeds, the producers have been able to buy more corn from Texas than they would have obtained had their crops been successful, and have had, in addition, and probably for the first time in their lives, some surplus cash to expend for other purposes. What sort of things these poor Mexican people would buy if they could, was indicated to the writer by seeing in the hut of a laborer, on the line of the Mexican Central Railroad—a place destitute of almost every comfort, or article of furniture or convenience—a bright, new, small kerosene-lamp, than which nothing that fell under his observation in Mexico, was more remarkable and interesting. Remarkable and interesting, because neither this man nor his father, possibly since the world to them began, had ever before known anything better than a blazing brand as a method for illumination at night; and had never had either the knowledge, the desire, or the means of obtaining anything superior. But at last, through contact with and employment on the American railroad, the desire, the opportunity, the means to purchase, and the knowledge of the simple mechanism of the lamp, had come to this humble, isolated Mexican peasant; and, out of the germ of progress thus spontaneously, as it were, developed by the wayside, may come influences more potent for civilization and the elevation of humanity in Mexico, than all that church and state have been able to effect within the last three centuries.

The projection and extension of the American system of railroads into Mexico commanded the almost universal approval of the people

of the United States. It was regarded as a measure in the interest of civilization, and as likely to be mutually and largely beneficial to the people of both nations. But for the United States and Mexico to maintain their present tariff restrictions on the international trade of the two countries, is to simply neutralize in a great degree the effect of the railways; and create conditions so antagonistic to the idea which a railway represents, that the investment of a large amount of money in their construction by citizens of the United States under existing circumstances, would seem almost akin to dementia. For it must be obvious that these restrictions produce exactly the same result as if, after the railways had been completed, an earthquake had thrown up a ridge directly across the lines, so steep and precipitous on the northern side as to add from thirty to forty per cent to the cost of all merchandise passing from the United States into Mexico, and so much more difficult of ascent on the southern side as to add some ninety per cent to the cost of all goods passing from Mexico into the United States. And, if such a physical calamity had actually occurred, the stockholders might reasonably doubt whether the lines were worth operating. But, at the same time, if there are any who expect that trade would immediately and largely increase between the two countries if all tariff restrictions were mutually abolished, they are certain to be disappointed. A large proportion of the people of Mexico—possibly nine tenths—will, for the present, buy nothing imported, whether there is a high tariff or no tariff—not because they do not want to, but because they are so poor that they can not buy under any circumstances; while the limited wealthy class will buy what they want of foreign products, irrespective of high duties. Again, the internal trade or distribution of merchandise in Mexico is, furthermore, largely in the hands of the Germans and English, who learn the language and conform to the customs and prejudices of the country much more readily than the Americans. They naturally prefer the products of their own countries; and German manufactures have been especially popular, "because they are as cheap as they are poor"; and the advantage of paying more for what will last longer is something very difficult to impress upon the ordinary Mexican. Another matter which practically works against the extension of trade with the United States is, that American houses will not sell their goods on the long credits demanded by Mexican purchasers. A gentleman conversant, through long residence in Mexico, thus writes in respect to this matter: "It is a serious mistake to look upon Mexican credit as something to be let alone. I can say with confidence, after diligent investigation, that mercantile credit in Mexico will average up as satisfactory as in the United States. Among the large mercantile houses in the interior of Mexico, as well as the importers, and the large sugar, grain, cotton, and cattle raisers, the moral sense in a square business dealing is as keen and as just and responsible as among the general run of customers in the United

States.* They are slow, but pay their bills, make few business compromises, and still fewer failures. From actual inspection of books of large houses in Mexico, exhibiting accounts of a series of years, I found that eighty-five to ninety per cent of long credit sales were paid in full. Not one American business man in five hundred will succeed in Mexico, for the sole reason that he attempts to force his own ways and methods upon a people whose habits and ways are the antipodes of his own. Our manners are not in accord with the extreme politeness and consideration to be found in Mexico. Business is largely done on the basis of feeling and sentiment, and established acquaintance. Neither has time nor money the transcendent value that it has with us." It is also interesting to note here, that for these, or some other reasons, there are comparatively few Jews in Mexico, and that as a race they do not seem to fancy the country, either as a place of residence or for the transaction of business.

But, notwithstanding all these obstacles to the extension of trade, the advantages from commercial intercourse with Mexico are all on the side of the United States. Commerce, in establishing a course between any two points, always follows the lines of least resistance. And to-day, through the establishment of railway lines, which furnish ample, rapid, and comparatively cheap facilities for transportation between the interior of Mexico and such great commercial and manufacturing centers as Chicago, Cincinnati, St. Louis, and Kansas City, the easiest movement for the commerce of Mexico is by and through the United States. One demonstration of this is to be found in the fact that the Mexican Central Railroad now carries considerable freight that comes to New York by European steamers, and is thence transported, in bond, by rail directly through to Mexico; to which it may be added that some $300,000 of this freight, during the past year, is understood to have been English agricultural machinery, which has been bought in preference to the world-wide famous American farm machinery and implements, and carried past, as it were, the very doors of the American competing factories! For such a singular result there are two explanations. One is, that not only in Mexico, but in all the Central and

* Consul-General Sutton, of Matamoras, tells the following story illustrative of the good faith in a mercantile transaction of the *rancheros* of Northern Mexico, the particulars of which were detailed to him by the parties concerned: "A German house in interior Mexico contracted for the purchase of two hundred mule-colts, to be delivered a year following; and payment, at the rate of twenty dollars a pair, was made in advance. A year elapsed, and the mules were not delivered. The head of the house would not, however, allow any message of inquiry or reminder to be sent, but remained quiet. A year after the stipulated time, the *rancheros* came in with the mules. There had been a disease and a drought, which had killed the colts the first year, and this was the reason assigned for not coming according to agreement. They sent no word, because it was so far, and they did not remember the name." When the firm counted the mules, they found that *three* had been brought for each pair stipulated and paid for; which was the way the *rancheros* quietly settled for their unavoidable breach of contract.

South American countries, the English and the German merchants take special pains, not only to adapt their merchandise to the peculiar tastes of the people with whom they wish to deal, but also to cultivate their good-will. The representatives of the United States, as a general rule, do neither. Another explanation is that our European competitors in foreign trade recognize at the outset, and at all times, that trade, especially when involving radical innovations on old-time precedents and usages, is not of spontaneous growth, but has got to be cultivated; that it is a system in which product is to be given for product, and service for service, and therefore, from its very nature, can not be a "one-sided business." Accordingly, the German and English merchants in Mexico take in exchange for such wares as they desire to sell, and at a certain price, whatever the Mexicans have to offer of their products. The American merchant, on the other hand, finding that the commercial policy of his country is based on the assumption that such a system of exchanges is not desirable, and that its existing laws make reciprocal trade difficult, does not seem even to attempt it. And in connection with this subject it may be stated, that during recent years German merchants have bought merchandise in New York, which American manufacturers have acquired particular advantages in producing, shipped the same to Hamburg, and after re-exporting to Mexico, sold them at cheaper rates than any American engaged in direct trade could afford to offer! How such a result, which on its face seems so mysterious and paradoxical, is accomplished, may be best explained by example. Thus, the German, who has become thoroughly conversant with Mexican methods of doing business, could sell say $3,000 worth of American cottons, furniture, sewing-machines, and the like, at cost, or possibly even less than cost, because his system of selling is to exchange them for $3,000 worth of Mexican products, which he can afterward sell, it may be, at $5,000, or a sum which would give him a fair return for all his risks and for long credits, and also reimburse him for all the expenses of extended transportation. And the Mexicans are contented with their share of the transaction, because nothing better is offered to them.

The annual value of the total import trade of Mexico is probably not in excess of $35,000,000; of which the United States already controls a large proportion. Thus, for the year 1883, the returned value of all merchandise exported from the United States to Mexico was $16,587,630; of which $14,370,992 was "domestic," and $2,216,638 "foreign" merchandise. This was, however, a year of very active railroad construction, with an abnormal employment of Mexican labor, and large disbursements of American capital in the country. Since then, there has been a marked falling off in exports from the United States (less than $13,000,000 in 1884), which has been attributed partly to the withholding of orders in anticipation of the ratification of a commercial treaty between the two countries, and partly to the

great depression of business consequent on the large decline in the price of silver.*

That the ratification of the contemplated treaty for commercial reciprocity between the United States and Mexico would have increased to some extent, and perhaps considerably, the volume of American exports, can not be doubted. Thus, for example, there are no articles of which Mexico stands in greater need than wagons and carts, barbed fence-wire, and petroleum and its derivatives for warming and lighting. In respect to the two first named, the existing Mexican tariff is almost prohibitory, and, as a consequence, it is asserted that there is not a respectable vehicle in any of the frontier towns of Mexico; and no means, in the absence of wood, of supplying a pressing and increasing need for fencing on the great *haciendas;* while the cost of all petroleum products is so much enhanced, as to greatly restrict their consumption for illumination and almost entirely preclude their use for warming, and this in a country destitute in great part of any cheap natural supply of either wood or coal. The removal of all duties on the import of merely these few articles into Mexico, as was provided in the proposed treaty, and their consequent very great cheapening, would therefore have been a boon to the people of Mexico, which they would not have failed to take advantage of to the utmost extent of their ability; and, for meeting any demand thus created, the manufacturers of the United States would have nothing to fear from any foreign competitors.

On the other hand, the arguments that have thus far proved most potent in preventing the ratification of such a treaty, on the part of the United States, have been based on the assumption that the free importation of Mexican raw sugars and unmanufactured tobacco, would prove injurious to the American sugar and tobacco interests. But the entire fallacy, or rather utter absurdity, of such assumptions would seem to be demonstrated: *First*, in respect to sugar, by the fact that, with unrefined sugar selling in Mexico for a much higher price (from twelve to twenty-four cents retail) than the same article in the United States, there have not yet been sufficient inducements held out to Mexican capital and labor, in the way of profit, to tempt

* How greatly the depreciation of silver affects the business interests of a country like Mexico, which not only uses a silver currency almost exclusively, but also relies on silver as one of its chief exports (i. e., for the payment of imports), is shown by the circumstance that the Directors of the Vera Cruz and City of Mexico Railroad reported at their annual meeting in London, on the 25th of May, 1886, that the loss of the company in exchange for the half-year ending December 31, 1885, was £29,641; on the gross earnings for the same period, of £302,134. They further add: "The average rate of exchange fell during the half-year from 41–46*d.* per dollar, at which it stood at the end of June 1865, to 40–45*d.* and since the beginning of the current half-year (1886) the rate has further fallen, and at the present time is 38–76*d.* On equal remittances made a year previously, when the average rate was 42–39, the loss would have been only £21,669, and thus an additional burden of £7,972 has been imposed on the shareholders."

them to fully supply to the domestic demand of the country for sugar from its undoubtedly great natural resources—*five and a half* dollars' worth of sugar having been exported from the United States into Mexico in 1883, for every one dollar's worth imported during the same year from Mexico into the United States ; and, *secondly*, in respect to tobacco, by the testimony, based on careful investigation, of some of the best manufacturing authorities in the United States, that, while the best grades of tobacco for cigar purposes can now be raised in the United States at from ten to fifteen cents per pound, the cost of Mexican tobacco of a corresponding quality ranges from twenty-five to fifty cents per pound. It is difficult to see, therefore, what valid objections from merely trade considerations can be offered to the consummation of such a measure on the part of the United States, or to affirm which of the two countries would be the greatest gainer from the adoption of such a policy. Nay, more, it would be difficult for any one to show, wherein anything of commercial or industrial disadvantage could accrue to the United States, even if it were to allow every domestic product of Mexico to be imported into her territory free of all import taxes or restrictions—articles subject to internal revenue taxes in the United States being manifestly excepted—without asking any like concessions from Mexico in return. Such a proposition may at first seem preposterous, but let us reason a little about it. In the first place, it is exactly the policy which Great Britain now offers to Mexico. Can the United States afford to bid less for the trade of the American Continent than her great commercial rival? Again, Mexico wants, or is likely to want, everything which the United States especially desires to sell, and the only drawback to a great extension of trade between the two countries is the lack of ability on the part of Mexico to pay for what she wants. And this inability at the present time is very great. Apart from the precious metals, the quantity and value of domestic merchandise which Mexico can export to pay for such foreign products as she may desire, as already pointed out, are comparatively small, and consist almost exclusively of the most crude natural products. For the year 1883 nearly eleven twelfths of all her exports consisted of the ixtle and heniquen fibers ; woods, mainly dye and ornamental ; coffee, hides and skins, vanilla, horse-hair, catechu, and sarsaparilla. Notwithstanding, also, that Mexico is an agricultural country, she does not produce sufficient material (cotton and wool) to keep her small number of textile factories in operation ; but imports about three fifths of her raw cotton from the United States (5,877,000 pounds in 1885), and a considerable portion of her wool from Australia. What Mexico would sell to the United States, if all tariff restrictions were removed from her exports, would be such crude materials as have been specified—all articles of prime necessity to the American manufacturer. Reduced to terms of labor, the exchanges would sub-

stantially be the product of twelve hours' hand-labor in Mexico for one hour's labor with machinery in the United States. A Committee of Ways and Means of the United States House of Representatives of the Forty-ninth Congress have reported adversely to the ratification of a commercial treaty with Mexico, mainly for three reasons: *First*, because Mexico is so poor; *second*, because "the American citizen living in Mexico, and pursuing the peaceful avocations of industry and commerce, is without adequate protection to life and property"; *third*, because "to speak of permanent and desirable commercial relations with a government and people so estranged from us in sentiment is without promise of substantial and successful results." The first of the reasons is economic, the second political, while the third, having due regard to its meaning, may be well termed "Mongolian"; and all are unsound. The poor countries are the very ones with which it is especially desirable that the United States should cultivate trade, for, if the volume of trade be small, the profit of such trade is large—as is always the case where the results of rude or hand labor are exchanged for machinery product. If the facts constituting the basis for the second reason are as alleged, commercial isolation and restriction are no remedy for them. Commercial intimacy between nations is always productive of political good-fellowship, as isolation and restriction are of enmity; and for promoting amity with Mexico the modern drummer is likely to prove, for the present, a far better missionary than either the diplomatist or the soldier; and, as for the third, one might think that a precedent had been borrowed by the committee from China, where commercial intercourse with the United States itself, in common with Europe, was, until very recently, combated on the ground that the inhabitants of these countries were "foreign devils," with whom the enlightened Chinese ought not to be brought in contact.

Such, then, in conclusion, are the views of the writer respecting the present and future relations of the United States to Mexico. If he has offered anything, in the way of fact or argument, which may induce a belief, by people of the former, that the subject is worthy of a larger and more kindly consideration on their part than it has hitherto received, he will feel that his "Economic Study" has not been wholly unsatisfactory.

THE EXTENSION OF SCIENTIFIC TEACHING.*

By Professor T. H. HUXLEY.

ONCE more reverting to reminiscence, the present state of scientific education surely presents a marvelous and a most satisfactory contrast to the time, well within my memory, when no systematic prac-

* From the President's Address before the Royal Society, delivered at the Anniversary Meeting, November 30, 1885.

tical instruction in any branch of experimental or observational science, except anatomy, was to be had in this country; and when there was no such thing as a physical, chemical, biological, or geological laboratory open to the students of any university, or to the pupils of any school, in the three kingdoms. Nor was there any university which recognized science as a faculty, nor a school, public or private, in which scientific instruction was represented by much more than the occasional visit of a vagrant orrery.

At the present moment, any one who desires to obtain a thoroughly scientific training has a choice among a dozen institutions; and elementary scientific instruction is, so to speak, brought to the doors of the poorer classes. If the rich are debarred from like advantages, it is their own affair; but even the most careful public-school education does not now wholly exclude the knowledge that there is such a thing as science from the mind of a young English gentleman. If science is not allowed a fair share of the children's bread, it is at any rate permitted to pick up the crumbs which fall from the time-table, and that is a great deal more than I once hoped to see in my lifetime.

I have followed precedent in leading you to the point at which it might be fair, as it certainly would be customary, to end by congratulating you, as Fellows of the Royal Society, on the past progress and the future prospects of the work which, for two centuries, it has been the aim of the society to forward. But it will perhaps be more profitable to consider that which remains to be done for the advancement of science than to "rest and be thankful" in the contemplation of that which has been done.

In all human affairs the irony of Fate plays a part, and, in the midst of our greatest satisfactions, "surgit amari aliquid." I should have been disposed to account for the particular drop of bitterness to which I am about to refer, by the sexagenarian state of mind, were it not that I find the same complaint in the mouths of the young and vigorous. Of late years it has struck me, with constantly increasing force, that those who have toiled for the advancement of science are in a fair way of being overwhelmed by the realization of their wishes. We are in the case of Tarpeia, who opened the gates of the Roman citadel to the Sabines, and was crushed under the weight of the reward bestowed upon her. It has become impossible for any man to keep pace with the progress of the whole of any important branch of science. If he were to attempt to do so, his mental faculties would be crushed by the multitudes of journals and of voluminous monographs which a too fertile press casts upon him. This was not the case in my young days. A diligent reader might then keep fairly informed of all that was going on, without robbing himself of leisure for original work, and without demoralizing his faculties by the accumulation of unassimilated information. It looks as if the scientific, like other revolutions, meant to devour its own children; as if the growth of science tended

to overwhelm its votaries; as if the man of science of the future were condemned to diminish into a narrower and narrower specialist, as time goes on.

I am happy to say that I do not think any such catastrophe a necessary consequence of the growth of science; but I do think it is a tendency to be feared, and an evil to be most carefully provided against. The man who works away at one corner of Nature, shutting his eyes to all the rest, diminishes his chances of seeing what is to be seen in that corner; for, as I need hardly remind my present hearers, that which the investigator perceives depends much more on that which lies behind his sense-organs than on the object in front of them.

It appears to me that the only defense against this tendency to the degeneration of scientific workers lies in the organization and extension of scientific education in such a manner as to secure breadth of culture without superficiality; and, on the other hand, depth and precision of knowledge without narrowness.

I think it is quite possible to meet these requirements. There is no reason, in the nature of things, why the student who is destined for a scientific career should not, in the first place, go through a course of instruction such as would insure him a real, that is to say, a practical acquaintance with the elements of each of the great divisions of mathematical and physical science; nor why this instruction in what (if I may borrow a phrase from medicine) I may call the institutes of science should not be followed up by more special instruction, covering the whole field of that particular division in which the student eventually proposes to become a specialist. I say not only that there is no reason why this should not be done, but, on the ground of practical experience, I venture to add that there is no difficulty in doing it. Some thirty years ago my colleagues and I framed a scheme of instruction on the lines just indicated, for the students of the institution, which has grown into what is now known as the Normal School of Science and Royal School of Mines. We have found no obstacles in the way of carrying the scheme into practice except such as arise, partly, from the limitations of time forced upon us from without; and, partly, from the extremely defective character of ordinary education. With respect to the first difficulty, we ought, in my judgment, to bestow at least four, or better five, years on the work which has, at present, to be got through in three. And, as regards the second difficulty, we are hampered not only by the ignorance of even the rudiments of physical science, on the part of the students who come to us from ordinary schools, and by their very poor mathematical acquirements, but by the miserable character of the so-called literary training which they have undergone.

Nothing would help the man of science of the future to rise to the level of his great enterprise more effectually than certain modifications,

on the one hand, of primary and secondary school education, and, on the other, of the conditions which are attached by the universities to the attainment of their degrees and their rewards. As I ventured to remark some years ago, we want a most-favored-nation clause inserted in our treaty with educators. We have a right to claim that science shall be put upon the same footing as any other great subject of instruction, that it shall have an equal share in the schools, an equal share in the recognized qualification for degrees, and in university honors and rewards. It must be recognized that science, as intellectual discipline, is at least as valuable, and, as knowledge, is at least as important, as literature, and that the scientific student must no longer be handicapped by a linguistic (I will not call it literary) burden, the equivalent of which is not imposed upon his classical compeer.

Let me repeat that I say this, not as a depreciator of literature, but in the interests of literature. The reason why our young people are so often scandalously and lamentably deficient in literary knowledge, and still more in the feeling and the desire for literary excellence, lies in the fact that they have been withheld from a true literary training by the pretense of it, which too often passes under the name of classical instruction. Nothing is of more importance to the man of science than that he should appreciate the value of style, and the literary work of the school would be of infinite value to him if it taught him this one thing. But I do not believe that this is to be done by what is called forming one's self on classical models, or that the advice to give one's days and nights to the study of any great writer is of much value. "Le style est l'homme même," as a man of science who was a master of style has profoundly said; and aping somebody else does not help one to express one's self. A good style is the vivid expression of clear thinking, and it can be attained only by those who will take infinite pains, in the first place, to purge their own minds of ignorance and half-knowledge, and, in the second, to clothe their thoughts in the words which will most fitly convey them to the minds of others. I can conceive no greater help to our scientific students than that they should bring to their work the habit of mind which is implied in the power to write their own language in a good style. But this is exactly what our present so-called literary education so often fails to confer, even on those who have enjoyed its fullest advantages, while the ordinary schoolboy has rarely been even made aware that its attainment is a thing to be desired.

A CANADIAN CHAPTER IN AGRARIAN AGITATION.

By GEORGE ILES.

WHEN agrarian agitation is mentioned, one expects to hear of Ireland, the Isle of Skye, Scotland, or England. That American communities have been, and are, little troubled by disputes between landlord and tenant, is taken for matter of course, and not without reason. When fertile wild land could be had for nothing till within recent years, the struggle between proprietors and would-be proprietors could seldom become very severe. Questions as to the ultimate ownership of land are still practically in abeyance in the New World. Yet America has furnished interesting instances of agrarian agitation. Prodigal grants of land at nominal prices to colonizing corporations and railway companies have induced bitter and increasing complaints in the United States and Canada. Mr. Henry George's attacks on landed proprietorship originated from observation of the grasping policy of Californian owners of counties who waited idly for their property to acquire value from the neighborhood of industrious settlers. In a new country such holdings are very grievous to working settlers. Large uncultivated blocks separate farmers from their markets, add much to local taxation for roads and bridges, and materially enhance the difficulties of maintaining district schools. Hence, in the New Northwest, both American and Canadian, the advantages obtained from railways, aided by large land grants, are not procured without some sacrifices. These sacrifices are, however, rendered temporary by the alacrity of railway companies in settling their lands with a view to developing traffic. Colonization companies, so called, are everywhere less eager to part with their tracts, and the difficulties arising from this fact sometimes occasion distinct agrarian agitation. In Ontario, the chief province of the Canadian Dominion, one of the grievances of a generation ago was the possession of extensive areas by the Canada Company, which obtained its holdings at a nominal price on conditions notoriously disregarded.

It is, however, the agrarian agitation which took place, for more than a century, in Prince Edward Island, the smallest province of Canada, that is to be here sketched. The course of the struggle there between landlord and tenant may have interest in showing how the grantees of lands bestowed for colonization may shirk their engagements. And it may also show how the voting privileges of a democratic community modified an opposition to landlords which in Cork or Kerry might have gone to murderous lengths.

Prince Edward Island is one of the most beautiful agricultural districts of America. Its forests, fields, and meadows, vested in the crown, were in 1767 disposed of according to a method much in vogue

during the early days of British colonization. With the exception of three small reservations, intended for county towns, the island was divided into sixty-seven lots or townships of 20,000 acres. In one day sixty-five of these lots were disposed of by lottery before the Board of Trade and Plantations in London! The grants issued to the various allottees contained these among other conditions:

1. That the grantee of each township should place on the same, within ten years from the date of the grant, one person for every 200 acres, the settlers to be foreign Protestants, or persons who had resided in British America for two years previous to 1767.

2. That such portions of the land, where one third of the acreage was not so settled within four years of the date of the grants, should be forfeited.

3. That payment of quit-rent, varying from two to six shillings sterling per 100 acres, should be made by the allottees at the expiration of five years, payable annually on one half the grant; and, five years after that, payable on the whole.

On these terms the original proprietors took possession, and in the following year petitioned the British Government that the island might be given a separate government. To defray its expenses they proposed that a moiety of quit-rents due in five years should become payable in two—during May, 1769—payment of the remaining half to be postponed for twenty years. Trusting to the good faith and responsibility of the proprietors, a local government was accordingly established. This trust was disappointed. The quit-rents were not paid as agreed, and ten years after the grants had been conveyed the conditions of settlement had been complied with in but ten townships of the sixty-five. Nine others were settled in part, and all the remainder neglected. In no case were the settlers the foreign Protestants bargained for.

As time passed, the proprietors continued their disrespect for the conditions of tenure. The Legislature of the island constantly directed the attention of the Government at Westminster to the facts, and urged the escheat of the grants; holding, perhaps not very warrantably, that after escheat the tenants would enjoy their lands on better terms. Indulgence, however, was from time to time sought and received by the proprietors. Nevertheless, in 1802, the Colonial Secretary, in a dispatch to the governor of the island, ordered that such lands as were held by proprietors who had failed to perform their conditions of grant be escheated. Accordingly, the Legislature passed an act, the result of which would have been to revest in the crown nearly every acre in the colony. What became of this law is a mystery; it was sent from Charlottetown, the colonial capital, to London, for the royal allowance, and was never afterward heard of. In this same year (1802), the arrears of quit-rents had accumulated to £60,000; and the British Government, wishing to encourage the set-

tlement of the colony, determined to accept a moderate commutation. Leniency or favor was invariably shown proprietors who had complied in any degree with the conditions of their tenure. Yet this liberal measure was unavailing—the commuted arrears were not paid. Up to 1833 but £6,000 had been received for quit-rents, whereas the total due under the grants was £145,000. Meanwhile agitation on the subject among the islanders constantly increased, until the British Government was again urged to quiet its perturbed little colony.

Lord Goderich, Colonial Minister in 1832, made a thorough examination of the complaints of the islanders, embodying the result in a lengthy dispatch. He found large tracts unimproved, in expectation that their value would ultimately be raised by the exertions of those colonists who were busy cultivating their property. Vast areas of wild land separated farms from one another, the injustice being heightened by absenteeism of the landlords. Lord Goderich proposed that the quitrents due by the proprietors be exacted, and, as a concession, should be redeemable at fifteen years' purchase. His proposal was not acted upon, and the agitation on the island rose to an extreme. All this, too, with peculiar political conditions. The local Government, in the immediate presence of its governed population, was extremely sensitive to popular discontent. Agriculture was the main and almost the sole industry ; the tenants were not mingled with any manufacturing or mercantile class, and the preponderant pressure of their interests was very manifest in a legislative hall which stood within an easy drive of the average island farm. The arm of law was enfeebled. Rents were usually allowed to fall into long arrears before resort was taken to legal measures of collection. It was common for a tenant to owe five to ten years' rent. Arrears, accumulated through sixteen and even eighteen years, were sometimes brought before the courts. Usually, in suits for rent, the landlord paid the costs himself, and did not exact interest. Frequently proprietary rights were disposed of to speculators for nominal sums. Every indulgence by landlord to tenant was interpreted by the latter as a just concession from the possessor of a faulty title. The cost of collecting such rents as were paid was commonly about one fourth.

For twenty-one years after Lord Goderich's vain recommendations, the agrarian history of Prince Edward Island was one of ceaseless turmoil. In 1853 an act was passed by the Provincial Legislature for the purchase of the estates of proprietors who might be disposed to sell. Between 1854 and 1871 thirteen estates, aggregating 457,260 acres, were bought at the moderate average price of \$1.31 per acre. Of this area, 403,050 acres have been sold to 5,704 tenants, who have paid, for their average holdings of 70 acres, prices ranging from 94 cents to \$3.40, and averaging \$1.76. This act of 1853, which depended on the voluntary sale by proprietors of their lands, was too slow in operation for the discontented islanders. They obtained the concur-

rence of the Legislature and the landlords to a proposal that a commission be appointed with power to devise a system whereby leasehold lands might be converted into freehold. Accordingly, in 1860 a commission was constituted—Hon. John H. Gray being nominated by the British Government, Hon. Joseph Howe by the Legislature of the island, and Hon. J. W. Ritchie by the proprietors. The Legislature, most anxious for the quieting of an agitation which had done the colony incalculable harm, passed an act in advance to give effect to the award of the commissioners. That award, however, had no sooner been published, than the proprietors objected to the manner in which it provided for the valuation of land. This objection was sustained, the award set aside, and another attempt to quiet the strife between landlords and tenants proved fruitless. Wild excitement prevailed as a result of what was regarded as the bad faith of the proprietors. An organization known as the "Tenant League" came into existence, and resistance was offered to the collection of rent by civil officers. Frequent and violent riots gave the appearance of Erin itself to the colony, and troops from Halifax were summoned to quell the disturbances.

In 1862 the Provincial Government passed an act which expired in 1874, intended to give peace to the island. Under it tenants could offer to buy leased lands from landlords at fifteen years' purchase, the Government aiding by an advance to the extent of eight shillings and sixpence per acre at six per cent interest, all arrears of rent to May, 1853, due by purchasers, being canceled. This act also proved disappointing. Few tenants availed themselves of it, the majority of leaseholders entertaining the idea that the lands would come to them on better terms of purchase than those provided in the act, very probably after reversion to the crown.

Recognizing the failure of every attempt at grappling with the land question, by means which left solution to voluntary sales or voluntary purchases, the Island Legislature in 1868 urged on the British Government the necessity for the adoption of compulsory measures. The plea led to no action, pending the proposed entrance of Prince Edward Island as a member of the Canadian Confederation. That Confederation, established in 1867, made repeated overtures for the admission of the province before the union in 1873 was perfected. The terms of union provided the means of solving the question which for more than a century had troubled a fertile and promising province. It was agreed on entering the Confederation that the Island Government, which had no public lands and was surrendering its right to customs levies, should receive from the Dominion treasury $800,000 ; this enabled the province to purchase the township lands from proprietors on terms intended to be just and equitable. Three commissioners were appointed for the duty of purchase ; the Governor-General appointed one, the Provincial Government the second, and each several

proprietor had the privilege of appointing the third for the hearing of his case. In estimating the compensation to be paid proprietors, the commissioners were required to consider :

1. The price at which other proprietors had already sold their lands to the Government.

2. The number of acres under lease in the estates valued, the length of such leases, the rents agreed for under these leases, the arrears of rent, the years over which they extended, and the reasonable probability of recovery.

3. The number of acres of vacant or unleased land ; their quality and value to the proprietor.

4. The gross rent actually paid for the previous six years ; the expenses of collecting such rent being deducted, to show the net amount actually received by the proprietor.

With Right Hon. Hugh E. Childers as chairman, the commission went to work, and the voluminous evidence presented to it reveals how thoroughly the tenants regarded their leases as unsound and illegal. Whenever a lease was taken as a basis of valuation, the plea was set up that the proprietor's title was faulty, and that he had leased property to which his right was doubtful. In vain was it contended that the whimsical conditions of the original grant had been impossible of fulfillment. The retort was repeated that, therefore, proprietorship should be forfeited, and it was held that landlord influences at Westminster had, in the early days of agitation, successfully fought off proposed concessions to tenants, which, if granted, would have spared the island grievous evils. The landlords maintained in their defense that their ownership had been repeatedly recognized by the Government, more particularly in the Fifteen Years' Purchase Act of 1865. They pleaded that, if they had not rigorously enforced claims against their tenants, their forbearance arose from no uncertainty as to their titles, but from humanity in cases where their tenants were needy, and from social and political prejudices against legal collection where their debtors were thriving. Leases, it was clear, were very far from being leases in the British, Irish, or American sense ; they were not contracts meaning what they said, but doubtful bargains open to discussion or rebate, just as the landlords' title could be discredited, indulgence obtained, or prosecution parried. Many tenants of rich land, abundantly able to pay their rent, had paid none. Often a tenant who had decried his leasehold as poor and unproductive, was proved to have disposed of it for a handsome sum. Parallel with the accumulating of arrears on landlords' ledgers had gone on the steady piling up by tenants as a class of savings in the banks. A disregard for property in rents extended itself to other kinds of property belonging to landed proprietors. It was not uncommon for woodlands to lose their value through being stripped of timber by thieves. When in an extreme case a tenant was ejected from his holding, no successor to him was to

be found. Once a sheriff bearing a writ was met by an armed mob, headed by a member of the Legislature.

A very significant element in the pleas made against the landlords, was that the labors of the tenants alone had imparted increasing values to the land in making fertile farms where there had been but wilderness. It was urged again and again that the toilers who had imparted value to property were entitled to proprietary rights, as against the holders of titles whose exertions had been confined to the collection of rent. Therefore, it was maintained, the Government should not, in buying lands, do so on the basis of capitalizing a rent which had, as a value, been chiefly created by the industry of tenants. A good many occupiers of land on short or uncertain leases plainly manifested the universal tendency of such tenure—bad farming and a feeble interest in improvement of any kind. Some of them were accustomed to reducing their indebtedness by sums ranging from five dollars down to five shillings. In every case the landlord's claim received such attention as it was convenient for the tenant to give it after the accounts of merchant, blacksmith, wagon-builder, or other creditor had been paid. This, too, when, even for good land, rent was rarely more than about ninepence sterling an acre. Incidentally, it was shown that the long coast-line of the island had had its effect in inducing many farmers to embark in fishing, and allegiance divided between land and sea gave agriculture but primitive development. Another fact of interest elicited was that the island had a most admirable fertilizer in the beds of mussel mud and shells bordering its shores, which, applied to the land, increased its yield from two to even ten fold for several years.

When the Land Commissioners had concluded their labors in court the experiment of tenant proprietorship began. It proved an experiment attended with many difficulties. The surveys of the lands had been very incomplete and imperfect, so that disputes as to boundaries were constant. The Government now finds that it has paid for 41,000 more acres than it has received. From doubtfulness in surveys and boundaries it was not uncommon for three or four persons each to claim the right to buy the freehold of the same property. The purchase of the land by Government having banished all fears of arrears of rent being exacted from former tenants, a general resurrection by former owners of old leases, agreements, and minutes developed an army of claimants for the right to buy. In addition to these elements of contention, the Government had to deal with hundreds of squatters, who by virtue of twenty years' occupation had acquired proprietary rights. During the years which have elapsed since the act went into force, its difficulties have been gradually overcome, chiefly through the judgment and ability of the commissioners who have administered it. Let some statistics of their labors be presented :

Up to December 31, 1885, the Government of Prince Edward Isl-

and had bought from proprietors 843,981 acres of land, and had sold 679,832 acres at an average price of $1.59 per acre. The usual Government terms of sale were one fifth cash, and the remainder payable in ten equal annual installments, with interest at six per cent. On December 31, 1882, the last date up to which statements regarding arrears were published, it was shown that by purchasers who had made no payments whatever during terms varying from three to fifteen years, $200,648 was due in arrears to the Government. A pretty general feeling seemed to prevail among them that new concessions would be granted delinquents, who as a class were numerous enough to make the authorities charged with collection very lenient indeed—to put it mildly.

In quieting disturbances and placing real estate in the hands of its occupiers and users, the Land Transfer Act did unquestionable good. In the passage and administration of the act a favoring of the tenants and ex-tenants is most manifest. Before sales to tenants began there was a classification of lands according to value, and tenants usually bought at prices somewhat below cost, and occasionally at prices much below cost. Tenants in buying properties which they had cultivated were freed from all arrears of rent due to the date of acquisition by Government. Improvements of all kinds which they had effected on their lands had been, and continued to be, their property; as such these improvements, houses, barns, fences, and what not, had entered into no calculation of the Government's when buying and selling.

Since the act went into operation a good many tenant-purchasers have sold out their holdings, and, considering the value of their improvements, usually at a marked advance on the purchase price, bearing out to some extent the complaints of the original proprietors that too little had been paid them. It is difficult to arrive at the truth of this much-disputed matter; a fair approximation alone is possible. Wilderness lands bought some years ago from the Government, and still unimproved, sell at a considerable premium. Cultivated farms do not as a rule realize so handsome an advance, and in their prices is to be considered the very variable element of value—tenants' improvements. It is generally thought in the island that something more than the mere sentiment of ownership as distinguished from tenancy was sought to be gratified by the land agitation. For twenty years before 1875 a suffrage practically universal was enjoyed by the island. A voting majority had it in their power to modify the tenure of property in their own interest, and they exercised it through their parliamentary representatives. To-day the effect of a habit of mind acquired in the years during which concession after concession was made to tenants is still plain. Arrears due the Government go on accumulating, it would seem, with the expectation that in the future they may be wiped off the slate. The tenants when they became purchasers had decidedly good bargains; they would certainly not have agitated as they did

merely to exchange rent for an equal financial burden of interest, yet, as events have proved, their bargains, though good, have been less profitable than was anticipated. Since 1875 the vast areas in the far West and Northwest brought under cultivation have greatly reduced the prices of farm produce, and have at the same time powerfully attracted the emigrating classes of the Atlantic seaboard.

Rhetoric, in so far as it prophesied a wonderful impetus to the island when leaseholds gave place to freeholds, has somewhat missed fulfillment. Unthrifty farmers were not born again to thriftiness by the act of 1875. The money-lender has taken the place of the landlord with a good many of them. His terms are not so easy, nor his methods so gentle, and already about a fourth of the farms of the island are mortgaged at rates of interest averaging about seven and a half per cent. A single solicitor in Charlottetown has stowed in his vault mortgages to the amount of half a million dollars, held chiefly by widows and orphans, whose claims, unlike those of the wealthy proprietors, are exigent and must be promptly met.

The lesson from the history of land-proprietorship in Prince Edward Island is applicable to a wider field than the little Canadian province. It marks the unwisdom of governments in granting large tracts to corporations or individuals on nominal terms. With the lapse of years, if holdings are retained by their original grantees, the rise in value is enormous, and a community which has chiefly created that value resents the levy of "unearned increment." The agitation in Prince Edward Island also illustrates how the wide franchises of democracy modify the violence of combats concerning questions of property. Even though the mistakes of the Old World be sometimes repeated in the New, though unwarrantable privileges be created or acquired, the people possess a power in the ballot-box which renders unnecessary those appeals to the cartridge-box which so often accompany transatlantic agitation. Perhaps, when English Hodge awakens to his new influence as a voter, laws partly of his making may take the color of his interests, and English landed property may be further shorn of privilege. Beyond that may also be exerted the sinister influence against contract to which law-makers with little property, or none, are ever strongly tempted.

GENIUS AND PRECOCITY.

By JAMES SULLY.

I.

THE idea that genius reveals itself early in life does not at once recommend itself to common sense. Observation of Nature as a whole suggests, first of all, perhaps that her choicer and more costly gifts are the result of a long process of preparation. And, however

this be, there is certainly more of moral suggestiveness in the thought that intellectual distinction is the reward of a strenuous adolescence and manhood than in the supposition that it can be reached by the stripling at a bound through sheer force of native talent. And it may not improbably have been a lively perception of this ethical significance which fostered in the classic mind so wide-spread a disbelief in early promises of great intellectual power. We find a typical expression of this sentiment in the saying of Quintilian: "Illud ingeniorum velut præcox genus non temere umquam pervenit ad frugem." That is to say, the early blossom of talent is rarely followed by the fruit of great achievement.

It is evident that this saying embodies something like a general theory of the relation between rank of talent and rate of development. Where superior intellectual ability shows itself at an early date, it is of the sort that reaches its full stature early, and so never attains to the greatest height. On the other hand, genius of the finer order declares itself more slowly.

In order to estimate the soundness of this view, two lines of inquiry would be necessary. We should need to ask, first of all, what proportion of those who had shown marked precocity have afterward redeemed the promise of their youth; and, secondly, what number of those who have unquestionably obtained a place among the great were previously distinguished by precocity.

These two lines of investigation are, however, in a measure distinct. It may turn out that a large proportion of clever children never attain to anything but mediocrity in later life, and yet that the majority of great men have been remarkable as children. Hence, we may confine ourselves in the present essay to the second branch of the above inquiry, the retrogressive search for signs of precocity in the early life of those who have attained distinction.

It is to be remarked that even the limited inquiry to which we propose to confine ourselves here is a complex one. It includes, at least, two distinct questions—namely, first, whether men of genius have, in the majority of cases, displayed marked ability at an early age; and, secondly, whether they have reached their full maturity of power and highest achievement early or late. It is specially important to distinguish these two points, because they are apt to be confused under the shifting significance of the word "precocious."

I shall confine myself, then, at the outset to the question how far, or in what proportion of cases, recognized intellectual eminence has been preceded by youthful distinction and superiority to others. And in order to narrow the inquiry still further, I propose to deal exclusively with those who have reached eminence in some branch of art or of literature. This will exclude those who have displayed genius in the region of practical affairs, such as the statesman, the soldier, and the ecclesiastic.

Within the boundaries thus drawn there appear to be seven groups sufficiently distinct and important to require separate examination. These are—1, musicians; 2, painters; 3, poets; 4, novelists; 5, scholars, including historians and critics; 6, men of science; and, 7, philosophers. These classes are marked off from one another partly by differences in the materials and the form of the production, and partly by differences in the intellectual implements employed, such as observation and sensuous imagination.

As indications of precocity we shall select, first of all, any manifestations in childhood or youth of an exceptional aptitude and bent corresponding to the special direction of the later development of the genius. Thus, in the case of the poet, we must note such boyish characteristics as an exceptional love of poetry, a disposition to dreamy abstraction, etc. With respect to evidences of general intellectual ability, such as a high place at school or college, these will have a very different value in different domains. In the case of the musician, for example, they would have little relevance—except, indeed, so far as want of application to the prescribed course of studies might serve as negative evidence of an absorbing interest in the self-chosen study. On the other hand, in judging of the precocity of the scholar the school reputation becomes an important ingredient of the case.

In looking out for evidence of special talent we may, in certain cases, find a number of data ready to hand. Thus, in dealing with a musician, we may consider the age at which executive skill was shown, the date of the first original composition, and, as a valuable supplement to these, the time at which music was seriously taken up as a profession. In the case of other sorts of talent such a variety of data may not be accessible.

Finally, after chronicling all indications of childish and youthful precocity, we have to record the age at which the first great work was achieved, a work that either at the time or later on came to be regarded as a title to fame.

In conclusion, I may say that I have confined the inquiry to modern celebrities. Our knowledge of the lives of ancient writers and artists is, as a rule, too scanty to yield the required data. And, even in the case of some modern men of mark, the want of a record of early years has compelled me to omit the names from my list. I have abstained, too, for obvious reasons, from including the names of living celebrities.

Taking the groups in the order indicated above, we shall, in the case of each class, look first of all for instances of remarkable precocity. We may then go on to inquire into the proportion of precocious to non-precocious members of the class.

Musicians.—The stories of the more remarkable instances of boyish musical talent, alike in execution and in composition, are prob-

ably well known to most readers, so that I may pass them over with a brief reference.

Mozart is, I believe, the true *Wunderkind* in the magical realm of music. He began to play at so infantile a period that no date is assigned. At four he could play minuets, in good style probably, for a year after he was exhibited in public. Early in his fifth year he composed concertos; at eleven he wrote an opera buffa, and so forth. Next to him, perhaps, comes Mendelssohn, who first played in public at the age of nine, and whose first dated work, a cantata, was written when he was eleven. Beethoven tells us that he began music in his fourth year, and that at nine he had outgrown his father's teaching. He is said to have written a cantata when ten, and it is certain that a composition for the piano (variations on "Dressler's March") dates from this year. Schubert is another conspicuous instance of early musical development. He, too, soon outstripped his teacher, who said he had got harmony at his fingers'-ends. At eleven he was sufficiently skillful with the violin to play that instrument in church, and at the same date he began to compose little songs.

The examples just cited illustrate what may be called all-round musical precocity. Others show early talent in a more restricted form of activity. A number of musicians distinguished themselves as lads by masterly execution. Meyerbeer, who as a young child could play any air he had heard, performed at a public concert at nine. Hillier did the same thing one year later. At the age of twelve Spohr played the violin in public. Mehul was installed as organist at ten.*

Among instances of early attempts at musical composition may be named the following: Schumann tells us that he composed before seven; Cherubini is said to have written at nine, Auber at eleven, Weber at twelve (his first opera dates two years later), David at thirteen, Lotti and Rossini at sixteen, and our own Purcell at seventeen.

We have now to note the very early age at which a number of eminent musicians entered on a regular curriculum of study with a view to professional life. Some of the greatest precocities, as Mozart, Beethoven, Schubert, Mendelssohn, etc., having had parents either themselves musical and able to be teachers themselves, or at least sympathetic and anxious to get musical instruction for their gifted children, may almost be said to have begun their professional career from their infancy; others began to study at a very early age. Thus Weber was sent by his father (himself a musician) to be instructed, at the age of nine. Puck began to study at twelve. In many cases we see the young musician's quenchless earnestness aided by the favor of influential friends, leading to an early devotion to the art, even in the teeth of parental indifference or active opposition. Handel and Haydn are striking cases in point.

* Two living musicians are remarkable instances of precocious executive talent: Rubinstein played the piano in public at ten, and Liszt at twelve.

I have here selected some of the more striking instances of musical precocity. But the question still remains, What proportion of eminent musicians showed marked taste and ability as children? In order to answer this question I have gone through forty names. Of these I find that thirty-eight displayed a decided bent to the art before twenty. This is expressly stated in most cases, and in the rest is clearly inferred from the date of study, or of the first musical composition. The two excepted names are those of Palestrina and Tartini. Of the early life of the former little is known; but it is fairly inferable that he took up music in his youth. Tartini is the only instance I have met with of a first impulse to music showing itself after twenty. He is said to have first taken up the violin to relieve the monotony of cloister-life. But the story has a suspicious touch of romance about it.

Of the thirty-eight who were precocious to the extent just defined, I have ascertained that twenty-nine are said to have shown a musical gift as children. There is some reason to suppose that others betrayed musical skill toward the end of childhood (about twelve). So far as I can discover, only in the case of two of the nine exceptions is there reason to conclude that there was no marked manifestation of ability in childhood. These are (an odd juxtaposition) Rossini and Wagner. The former, says Brendel, though early subjected to musical discipline by his parents, themselves musicians, showed himself at first indocile and disinclined (*abhold*) to the art. Only in his seventeenth year does this distaste appear to have given way to genuine devotion. R. Wagner tells us that as a child he was not specially attracted to music, and that it was only when, at the age of fifteen, he made the acquaintance of Beethoven's symphonies, that he became inspired by a strong and overpowering passion for the art.

The date of a first musical composition is less easily obtainable than that of a first literary publication. I have managed to ascertain it in twenty-seven instances. Out of these, ten began to compose before the age of fifteen, fourteen more between fifteen and twenty, and only three after twenty.

If, now, we go on to examine into the age at which musical composers gave a distinct pledge of their greatness by a work of undoubted excellence, or at least of such merit as to win public recognition, we find much greater diversity. In some cases of early production the quality of the work was striking in itself and apart from the age in which it was produced. This applies to some of the most marvelous instances of precocity. Thus, Mozart, after gaining renown as a wonder-child by his symphonies, sonatas, etc., proceeded rapidly to lay the foundations of a lasting fame by operatic compositions. At the age of fourteen he acquired great popularity in Italy as an opera-writer, and by his nineteenth year had struck out his own original line in the opera, "La bella finta giardiniera." Mendelssohn was no less agile in

climbing the difficult height of fame. His early creative activity has the same exuberance, the same prodigality as that of Mozart, and the quality of this early production may be seen in the fact that he was only seventeen and a half years old when he composed the well-known overture to the "Midsummer-Night's Dream." The development of Schubert's genius exhibits a similar velocity of movement at the outset. After trying his hand at smaller compositions he essayed a symphony in his seventeenth year, and a few months after produced his first mass—a work, says Sir G. Grove, which is as striking an instance of early ripeness of talent as Mendelssohn's overture.

If we compare with this rapid upward movement the early course of Beethoven's genius we see a marked difference. If, says the authority just quoted, we compare what this composer had done by twenty-two with the abundant productivity of the three others by the same age, we have to pronounce the works to be few and unimportant. He has to show against Mozart's thirty-six symphonies only one, and against the same writer's twenty-eight operas, cantatas, and masses, nothing at all. It was not till the age of twenty-five that Beethoven published works of high importance (including the first three sonatas for the piano, and the song "Adelaide"). And he first attacked large compositions, quintets for strings, symphonies, etc., in his thirtieth year.

Backwardness in original musical production is exemplified by two writers of opera, Gluck and Wagner, both of whom began as imitators of others, and only struck out a new path in middle life. Another example is Sebastian Bach, who did not compose till after forty. But perhaps the most noteworthy instance of late musical development is Haydn, who, though he gained a certain limited reputation in his youth, did not divulge the secret of his great powers till toward the age of sixty.

Nevertheless, in spite of these inequalities, it may be safely said that, as a rule, the great musical composers have redeemed the promise of a precocious youth with a creditable alacrity. This may be seen by a glance at the following figures: Out of thirty names selected for examination, I find that eighteen unquestionably reached eminence under twenty-five, or twenty-two in all under thirty; leaving eight who attained fame after thirty. Thus about three fifths of the illustrious names in the history of music came into possession of their full intellectual heritage on, or soon after, attaining their majority.

Painters and Sculptors.—The history of art is so rich in illustrations of precocity that it is difficult to select the best examples. Mantegna showed such marked ability as a child that he was taken up by a patron and entered by his master in the guild of painters before the completion of his eleventh yoar. Again, Andrea del Sarto is said to have shown fondness for drawing as a child, and at the early age of seven to have been introduced to the world of art in the shop of a goldsmith. Raphael seems to have been a painter from the cradle. He

was sent to learn of Perugino when twelve years old, and at seventeen was painting on his own account. Tiziano showed as a child a decided preference for art over classics, and painted at the age of twelve a Madonna and Child in the tabernacle of a house, and about two years later studied under Gentile Bellini. Tintoretto used as a child to draw on the walls of his father's house, and received the name by which he is most widely known at this early date. Hardly less striking in his precocity is Michael Angelo, who as a lad kept running off to the studios, and at fourteen was received by Ghirlandajo as a regular pupil.

Turning from Italy we meet with no less interesting illustrations of artistic precocity. Murillo displayed talent as a child, covering the walls of his house with his drawings. It is said that he painted pictures as a boy and sold them at the fair. Holbein, who was taught at an early age by his father, painted finished pictures by the age of thirteen. Ruysdael is said to have painted notable pictures at twelve. At the same age Cornelius painted original compositions in the cathedral at Neuss, which show great talent. Vernet helped when a boy to paint his father's pictures. Ary Scheffer, the son of a painter, painted from early childhood, and exhibited in the Amsterdam Salon at twelve.

Among sculptors, Canova is said to have carved a lion at twelve. Thorwaldsen entered on a regular course of study at eleven.

Coming to our own country, we find instances of precocity which equal, if indeed they do not surpass, those furnished by other countries.

Perhaps the most remarkable instance is George Morland. He is said to have taken to pencil and crayon almost as soon as he left the cradle. Sketches of his made at the age of four, five, and six, were exhibited to the Society of Artists, and won praise for the child-artist. Sir Thomas Lawrence was another childish marvel. As a small boy he could draw portraits, and at nine not only copied historical paintings in a masterly style, but succeeded in compositions of his own. At ten his childish fame was such that he was sent by his father to Oxford to paint bishops, earls, and other notabilities—an experiment which brought great gain to his impecunious parent. At seventeen the period of his riper and more lasting fame commenced. With these instances must be reckoned Landseer, who, taught by his father, could draw well at five, and excellently at eight. When only thirteen he drew a majestic St. Bernard dog which was etched by his brother, and in the same year pictures of his appeared in the Royal Academy under the name of Master E. Landseer. Gainsborough was a confirmed painter at twelve. Turner, though hampered by poverty, made such progress that he exhibited at fifteen. Wilkie says he could draw before he could read, and he exhibited at fourteen. Flaxman amused himself when a sickly child by drawing in crayons, and exhibited busts at fifteen.

Reference has already been made to the early age at which artists have seriously taken up art as the work of their life. In many cases this date alone sufficiently attests the presence of childish gifts. Two great Italian painters, Perugino and Tiziano, are said to have studied painting at nine. Correggio is known to have begun his studies before thirteen. Van Dyck was taken in hand by his father at eleven. Rubens, to the distress of his mother, who was ambitious for what she deemed a higher career for her son, was sent to learn painting at thirteen.

Following the same method as that pursued in the case of musicians, we may now seek to give numerical precision to our investigation. I have taken fifty-eight artists, consisting of painters, sculptors, and architects, of whose early years I have been able to obtain any information. Of these I find that forty-two, that is to say, about three out of every four, are credited with having shown a decided skill before the age of fifteen. Or, if we take the age of twenty as our limit, we have forty-seven, or about four out of five, instances of precocity. To this it must be added that in eight cases, not included here, we are told that the artist showed talent, or attained distinction, early in life. And we may perhaps safely include one half of these under the head of manifestations of talent before twenty. By so doing we should raise our proportion to $\frac{51}{58}$, or about eight out of nine.

With respect to the date of the first completed work, I have been able to collect a fair number of facts. Thus, out of forty-two cases inspected, nine produced work before fifteen, sixteen between fifteen and twenty, fifteen between twenty and twenty-five, one between twenty-five and thirty, and one after thirty.

If now we inquire into the age at which real distinction was attained, and the first fruits of a permanent reputation reaped, we find, in general, that this date accords with the very early indication of taste and skill. In the case of more recent artists, we have, among the data which point to early eminence, the winning of academical prizes, and admissions to the walls of exhibitions. Instances of early prize-winners are Thorwaldsen, Ingres, and Wilkie. Reference has already been made to the early age at which Ary Scheffer, Morland, Turner, and Landseer, succeeded in getting their works exhibited.

In many instances we know that the artist made his mark in youth, or very early manhood. Mantegna painted pictures of exceptional excellence at seventeen. Fra Angelico was a skilled artist at twenty. Another early Italian artist, Orcagna, had fully established his reputation about the age of twenty-two. Ghiberti attained notoriety by his successful design for the bronze doors about twenty-one or twenty-two. Coming to later workers, we find it recorded that Leonardo painted finished pictures at twenty. Michael Angelo produced great works by nineteen. Raphael painted fine pictures at twenty-one. Titian became a distinguished painter at about twenty. Correggio

struck out his original manner about eighteen, and reached fame soon after twenty. Holbein is known to have painted good works at the age of fifteen, and at nineteen produced fine examples of finished portraiture. Van Dyck, too, painted exquisite portraits at twenty-one. Rubens had made his mark by excellent work at twenty-three. Rembrandt was famous at twenty-four, and about the same age Velasquez won royal recognition. Vernet painted considerable works at twenty-two. In our own country Landseer is again one of the most striking examples. By the age of eighteen he had won recognition as a great artist, and had more work than he could do. Lawrence was about the same age when he established his reputation as a finished painter. Turner painted pictures at eighteen which display real power. Reynolds had won a European reputation by twenty-three, and Romney's finer work dates from about the same age.

Here again figures may be useful. Out of a list of forty-two about the date of whose attainment of fame-bringing excellence I have been able to inform myself, twenty-eight reached this point before twenty-five, nine more before thirty, and the rest soon after that date. I can not find an instance of artistic fame having been reached after the age of forty.

A word or two may suffice respecting the few exceptions to the rule of the early manifestation and rapid growth of artistic genius. In one case, that of Ghirlandajo, we are explicitly told that distinction was not reached till after thirty. In another, that of Francia, I have gone by the fact that the earliest dated work belongs to the age of forty. Perhaps the most striking example of an undoubtedly late bloom of artistic genius is that of Sir Christopher Wren. He first distinguished himself in the realm of science (particularly mathematics and medicine), and suddenly showed himself a great architect about the age of thirty.

Poets.—A goodly collection might be made of stories of famous poets who have "lisped in numbers." I mention a few of the more interesting cases.

Among the great Italians Tasso is perhaps the most conspicuous example. Wonderful anecdotes are related of his childish powers. In his seventeenth, or at the latest in his eighteenth year, he wrote "Rinaldo," a work which instantly brought him renown. Gordoni, the comedian, showed his bent as an infant by choosing puppets for his playthings, and he astonished his friends by knocking off a sketch of a comedy at the age of eight. Metastasio, as a child, improvised in the streets, holding a crowd in admiring attention, and translated the "Iliad," at twelve. The great Spanish dramatist, Calderon, is another clear instance of precocity. His development was so rapid that at the age of thirteen he went to the high-school at Salamanca, and at fourteen wrote his first play. Among German poets, Goethe, the greatest, is also the most precocious. He is said to have composed dialogues

between six and eight. His first poems date from the sixteenth year, and by twenty-two he sounded in his "Götz von Berlichingen" the new national note in German drama. Among French poets Alfred de Musset, who had excited the envy of his comrades at school by his quickness, composed poems at fourteen. Perhaps, however, the most valuable example among French poets is Victor Hugo, who was called an "enfant sublime," began as a school-boy to write poems, both translations and original compositions, by sixteen produced finished works of lasting value, and by twenty-five was the acknowledged leader of the Romantic movement.

Among our own poets one can find instances of precocity which in no wise fall behind those just quoted. Beginning with the sixteenth century we have Beaumont, who was called by Wordsworth the eager child, and who seems to have composed tragedies at the age of twelve. Next comes the name of Cowley. In his tenth year he wrote an epical romance, which, according to an eminent living critic, though marked by faults of immaturity, is enriched by considerable merits, and is "the most astonishing feat of imaginative precocity on record." He followed up this first effort so well that he was famous before fifteen. Coming to the last century the name of Pope at once arrests our attention. When a child he was a skilled satirist. At twelve he took upon him the responsibilities of self-tuition, and at the same age produced what have been described as the "beautiful and touching" stanzas on "Solitude." Of the present century poets Byron and Coleridge are the most famous examples. Byron, who was deeply in love before ten, wrote before fifteen poems which bear the stamp of genius, and by twenty-one made himself famous by his brilliant satire, "English Bards and Scotch Reviewers." Coleridge was "filled with poetry and" (odd assortment) "metaphysics" at fifteen; and at sixteen he had produced poems bearing the unmistakable marks of genius.

Our poetesses do not lag far behind their brothers. At least we have two names to set against the list of male precocities. One of these, indeed—Elizabeth Barrett Browning—ranks among the phenomenal instances of early intellectual prowess. At eight she read Homer in Greek, and at the same age began to write poetry. At eleven or twelve she wrote an epic, which her father printed. And before fifteen she produced works which attest true genius.* Mrs. Hemans, the other poetess referred to, was a clever, self-taught child, and published a volume of poems at the age of fourteen.

In order to ascertain what proportion of the world's singers gave early promise of their vocal powers, I have gone through fifty-two records of modern poets. Of these, thirty-nine, that is to say three out of four, were distinctly precocious. Many of them began to versify in early youth. A large proportion betrayed as children a strong

* I am indebted to Mr. Leslie Stephen for some of the facts relating to Mrs. Browning.

bias to dreamy contemplation and solitude. In respect of methodic learning, a good number, if not the majority, appear to have been sadly wanting.

Poets rank high, too, in the matter of early production. After going through a series of sixty names, I find that thirty-eight, or very nearly two thirds, wrote before twenty. Of the others, seventeen began to write before thirty. Thus only five, that is to say, one out of every twelve, took to poetic composition after thirty.

The plant of poetic genius is not only early in disclosing its young shoot, but grows rapidly to the stature that commands admiration and renown. In some cases, as those of Tasso, Goethe, Coleridge, Campbell, and Moore, recognition follows almost instantaneously. In a much larger number, including Milton, Pope, Byron, Keats, and Voltaire, fame is reached after a very few years.

After examining forty-nine cases, I find that twenty-eight, or four out of seven, won renown by the age of twenty-five. The proportion of those who were famous by thirty is thirty-six, or more than five out of seven. Finally, forty-five, or nearly thirteen out of fourteen, had attained fame before forty, leaving only four who attained this point later in life.

Turning now to our list of exceptions, it is to be observed that in some cases—e. g., Chaucer, Marlowe, and Corneille—the record of early life is too meager to allow of our being sure that there were no manifestations of precocity.* One of our exceptions, indeed—Dante—appears to have shared with Byron a precocious development of the sexual emotion. But, allowing for uncertainties, there is a clear residue of cases in which the gift of poetic utterance revealed itself late. Camoëns, Racine, Goldsmith, Cowper, Wordsworth, may be cited as examples. The last two poets, together with Dryden and Dante, make up the four who missed renown till after forty. Of these, Cowper appears not to have begun to write till after that age. Dante, like Milton, passed his early manhood in the service of the state. Dryden and Wordsworth began to write when young, and so are signal examples of a long, unrewarded fidelity to the Muse.†

Novelists.—Among writers of fiction we find a number who displayed imaginative power in early life. Scott, who was at the University of Edinburgh at twelve, neglecting the regular academic studies for romances, began about this date to practice the invention of stories with a college friend. Dickens is a more impressive instance still. Forced, when a child of nine, to go out into the world and earn his livelihood, he indulged his irresistible bent to fiction not only by a

* Much the same remark applies to Shakespeare, whose first poetic effort I have set down as dating from his twenty-eighth year.

† The Greek and Latin poets supply several alleged instances of precocity. Living poets seem, as far as I can judge from the date of their first publication, to be somewhat below the average in this respect.

vivid realization and reproduction of the creations of others, but also by original inventions, the recital of which brought the lad a high renown among his companions, and, spite of poverty, he succeeded in publishing his first novel by the age of twenty-two. Another striking instance is Lytton, who published poems at fifteen and produced his first novel by twenty-two. Among foreign novelists we have Balzac, who, when a schoolboy, excogitated a theory of the will, and began to publish novels soon after twenty; and Hoffmann, who was a marvel of boyish cleverness, and who began to write novels soon after leaving school.

Among lady novelists instances of precocity are Charlotte Brontë and her sister, who, as soon as they could read and write, began to invent and act little plays of their own. By the age of fourteen Charlotte had put together a number of stories as well as poems and plays. But it was not till the age of thirty that she prepared her first considerable novel, "The Professor." Emily, who was two years younger than her sister, completed her "Wuthering Heights" about the same time. Another instance is Miss Burney. As a child she was remarkable; she taught herself to read and write, and became an incessant scribbler of verse and prose. She was not much more than fifteen when she planned the story of "Evelina," though it was not actually written till some years later, and only published when she was twenty-six.

Taking twenty-eight novelists, I find that in twenty-one cases, that is, in three cases out of four, there is evidence of imaginative power showing itself before twenty. Sometimes this evidence is of a curious character, as in the case of Richardson, who at the age of thirteen displayed his skill in letter-writing by acting as confidential secretary to three of his girl acquaintances, inditing or correcting their answers to the epistolary effusions of their lovers.

Novelists exhibit much diversity of habit with respect to the date of their first appearance before the public. In a list of thirty-two names two published their first work before twenty; seven between twenty and twenty-five; nine between twenty-five and thirty; seven between thirty and forty; and seven after forty. It may be observed that names of world-wide reputation appear in each group except the first. Thus Dickens and Hawthorne fall under the first of the four divisions; George Sand, Thackeray, and Victor Hugo under the second; Fielding, Goldsmith, and George Eliot under the third; and Defoe, Richardson, Sterne, Scott, and Cervantes under the last.

The date at which the first notable work appears varies in very much the same way. In a series of thirty-one names, three produce a work of note before twenty-five; nine more before thirty; twelve more before forty; and seven after forty.

The most remarkable examples of late development are Defoe, who, after devoting the best part of his life to political polemics, suddenly

struck into the path of fiction at the age of forty-four, and only gave his "Robinson Crusoe" to the world eleven years later; Richardson, who published his first fiction when fifty-one; Sterne, who, after passing many contented years in the seclusion of a country rectory, tried his luck as a novelist by publishing "Tristram Shandy" at the age of forty-six; and Cervantes, who, after years of active service, followed out an early impulse to letters in his thirty-sixth year, and produced his masterpiece at the mature age of fifty-seven.

SCHOLARS, HISTORIANS, CRITICS. — In this rather miscellaneous group we have a number of first-rate instances of precocity. Grotius has been pronounced one of the greatest of prodigies in this respect. At nine he wrote good Latin verses; at twelve he was ripe for the university; at fifteen he was editing the encyclopedic treatise of Capella; and at seventeen did excellent scholarly work. Our own Porson, the son of a parish clerk, at a very early date attracted notice by his exceptional powers of acquisition. At nine he could extract the cube root of a number by a process of mental arithmetic. Before fifteen he was able to repeat the whole of Horace, Virgil, and many parts of Livy, Cicero, etc. His productive work began later (twenty-four). Niebuhr resembles Porson in being the son of poor parents, and having a predilection at first for mathematics. At seven he was regarded as a marvel of boyish erudition. Among our own historians, Macaulay and Thirlwall are distinguished by precocity. Macaulay, whose extraordinary power of retention is well known, showed a decided bent toward literature as a child. Before eight he had given a presage of his historical work by putting together a compendium of universal history. By the same date he had written a romance, and soon after composed long poems. Thirlwall is a still more wonderful example. The son of a clergyman, he was taught Latin at three, and by four could read Greek with a fluency which astonished his family. He began to write at seven, and at twelve appeared before the world in a volume entitled "Primitiæ," which contained essays, and poems on various subjects, grave and gay. Soon after twelve, when at Charterhouse, he wrote elaborate letters in Latin, showing extraordinary reading and critical judgment.

If now we inquire what proportion of the class were distinguished for intellectual prococity, we reach the following results: Out of thirty-six cases, thirty, or five sixths, are said to have been distinguished by preternatural ability, either in childhood or in early youth. So far as I can ascertain, about one half of these betrayed at an early age the precise direction of their future mental activity. This applies, for example, to Gibbon, De Quincey, Hazlitt, and Lessing. The others either proved themselves quick all-round learners, or evinced exceptional intellectual strength in some other direction—e. g., mathematics or poetry.

It becomes a very different question if we inquire into the age at

which original production commenced. Out of a list of thirty-five it would seem as if only seven—that is, just one fifth—published before twenty. Eighteen more commenced their literary career between twenty and thirty; four more between thirty and forty; leaving six who began to write after forty.

With respect to the age at which a position of eminence is reached, our present group shows still wider variations than the previous ones. An inspection of a series of thirty-five writers gives the following results: only seven, or one fifth, won distinction before twenty-five; nine more before thirty; sixteen more before forty; leaving three unrewarded till after this date.

I may add that where—as often happens in the case of scholars and historians—a wide reputation is at once secured by a masterpiece, the appearance of this commonly falls in the thirties at the earliest. Niebuhr's first volume was published when he was thirty-nine; Thirlwall's when he was thirty-eight; Grote's, though conceived about thirty, not till fifty-two. On the other hand, literary critics—as Addison, Diderot, Lessing—have frequently obtained recognition by some excellent piece of work before thirty.—*Nineteenth Century.*

[*To be continued.*]

THE PROGRESS OF PSYCHICAL RESEARCH.

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THERE was a time when philosophy might have been defined as the science of human activity, so all-comprehensive was it. The ambitious Greek who would attach his name to a philosophical system must include in his scheme all that could be known, done, and speculated about God, the world, and man. In the course of time and the specialization of the sciences this view of philosophy fell away, and was replaced by the more exact and narrower conception of modern times.

But it is a question whether science, particularistic in its early history, is not aiming to reach the position which philosophy has retired from. If we take science to mean classified knowledge, then this increase of its field is but natural, and marks the progress of man's domination over the external world.

The last bit of territory which science has invaded, and which, in time, it hopes to claim for its own, is an especially interesting one; and, in response to the many inquiries, credulous and skeptical, which are raised, both in public and in private, we wish to give a brief sketch of the progress which science has thus far made in its new field.

As far back as our records reach—perhaps, as Mr. Spencer thinks, from the childhood of our race—a belief in the existence of invisible and, on physical grounds, unexplainable beings and modes of action has existed in human society. Sometimes this belief has dominated a larger, sometimes a smaller portion of mankind, and the attitude of the intelligent classes toward it has correspondingly varied. In our own day this belief not only exists, but it influences a far greater number of persons than the chance observer supposes.

Of late years the effects of this belief in supersensible beings and influences have shown themselves in many ways and places, particularly in Great Britain and America. We have heard of numberless clairvoyants, spiritualists, mesmerizers, and mind-readers. The nineteenth-century scientist has hitherto found no leisure to investigate the many remarkable occurrences that, from time to time, have been spoken and written of; or, if he has had the leisure, he has spurned the reports of these occurrences as beneath his notice as an educated and well-balanced man. Nevertheless, the fact that such occurrences as we refer to, numerous instances of which are familiar to every one, have been allowed to pass uninvestigated, has been a standing reproach to true science. Science prides itself on dealing with phenomena of any kind whatsoever, without fear or favor. And these occurrences, and the belief which many intelligent men and women hold in reference to them, are certainly phenomena. Grant, for the sake of argument, that the occurrences are fictitious and fraudulent, the belief in them remains as a phenomenon in human nature. Instances of this form part of our experience quite as truly, if not so frequently, as the sensations of heat and light do. If they are false, let us know the fact on demonstrable grounds; if true, let us know how and why. At all events, we must have scientific knowledge concerning them.

If this investigation is to be scientific, it must be undertaken in a thoroughly impartial spirit. We must lay aside our preconceived notions, and examine the facts as we find them. We want to know the truth, the whole truth, and nothing but the truth.

About four years ago certain gentlemen in England, all of them well known in their respective callings, found that they held substantially the opinions which we have just outlined, and the result was the formation of a Society for Psychical Research. It is to the work of this society that we desire to call attention.

The *personnel* of the society is remarkable, and of a character to command the greatest respect and confidence. The first president was Henry Sidgwick, the distinguished Professor of Moral Philosophy at Cambridge, and on the list of the earliest officers and council we find such names as those of Professor Balfour Stewart, Professor Barrett, of Dublin, Richard H. Hutton, Edmund Gurney, and F. W. H. Myers. That the principle and work of the society continue to inspire confidence may be inferred from the fact that, since its organization in

1882, the society's membership has increased to almost one thousand, and on its roll we find the honorable names of Gladstone, Ruskin, Tennyson, Earl Russell, Lord Rayleigh, the Bishop of Carlisle, the Bishop of Ripon, John Addington Symonds, Canon MacColl, and scores of others distinguished in politics, literature, and science.

That a thoroughly scientific spirit is actuating the society's work will be seen by an extract from its official publications. At the time of organization we read: "It has been widely felt that the present is an opportune time for making an organized and systematic attempt to investigate that large group of debatable phenomena designated by such terms as mesmeric, psychical, and spiritualistic. From the recorded testimony of many competent witnesses, past and present, including observations recently made by scientific men of eminence in various countries, there appears to be, amid much illusion and deception, an important body of remarkable phenomena, which are, *prima facie*, inexplicable on any generally recognized hypothesis, and which, if incontestably established, would be of the highest possible value. The task of examining such residual phenomena has often been undertaken by individual effort, but never hitherto by a scientific society organized on a sufficiently broad basis."

The field for operation was so extensive that there was naturally some difficulty in determining the point of beginning work. But, after due consideration, the following programme was drawn up, and a special committee was intrusted with each of the six subdivisions of the society's work:

"1. An examination of the nature and extent of any influence which may be exerted by one mind upon another, apart from any generally recognized mode of perception.

"2. The study of hypnotism and the forms of so-called mesmeric trance, with its alleged insensibility to pain; clairvoyance, and other allied phenomena.

"3. A critical revision of Reichenbach's researches with certain organizations called 'sensitive,' and an inquiry whether such organizations possess any power of perception beyond a highly exalted sensibility of the recognized sensory organs.*

"4. A careful investigation of any reports, resting on strong testimony, regarding appearances at the moment of death, or otherwise, or regarding disturbances in houses reputed to be haunted.

"5. An inquiry into the various physical phenomena commonly

* The phenomena described by Baron Karl von Reichenbach (born 1788) were these: Certain persons declared to him that ordinary magnets, crystals, the human body, and some other substances were to them self-luminous, presenting singular appearances in the dark, and otherwise distinguishable by producing a variety of peculiar sensory impressions—such as anomalous sensations of temperature, bodily pain or pleasure, unusual nervous symptoms, and involuntary muscular action. These are generally (but Reichenbach believed not necessarily) accompanied by abnormal physiological and mental states.

called spiritualistic, with an attempt to discover their causes and general laws.

"6. The collection and collation of existing materials bearing on the history of these subjects.

"The aim of the society will be to approach these various problems without prejudice or prepossession of any kind, and in the same spirit of exact and unimpassioned inquiry which has enabled science to solve so many problems once not less obscure nor less hotly debated. The founders of this society fully recognize the exceptional difficulties which surround this branch of research, but they, nevertheless, hope that, by patient and systematic effort, some results of permanent value may be obtained."

In accordance with this programme, the society went to work. Generous donations of money were received, and there were numerous accessions to the membership. It is a mistake to suppose that membership in the society implies anything more than a genuine scientific interest in the investigations. The constitution of the S. P. R., as it is popularly known in England, expressly states that membership in the society "does not imply the acceptance of any particular explanation of the phenomena investigated, nor any belief as to the operation in the physical world of forces other than those recognized by physical science."

Notwithstanding all these precautions, it was asserted in many quarters that the society had in view a particular explanation of the phenomena it was investigating. Professor Sidgwick, in his first presidential address, commented upon the criticisms passed upon the foundation of any such society, and succinctly explained and defended its course of action. In this address, Professor Sidgwick had occasion to define what the society meant by "sufficient evidence" for the phenomena with which it proposed to deal, and he declared that "sufficient evidence is evidence that will convince the scientific world, and for that we obviously require a good deal more than we have so far obtained." In the face of this, it is plain that Professor Ray Lankester's comment, "puerile hypothesis," would have been more in the nature of a scientific judgment had it been delivered after a review of the testimony, and not before.

From the date of organization until the present time the council and committees of the society have labored assiduously. Facts were the great desideratum, and they have been looked for in every conceivable place. Records of experiences were invited from any and every quarter, and many thousands have been received. It is characteristic of the society's method that no story has been accepted as genuine on newspaper testimony, or on second-hand evidence of any kind. In each case places and dates were verified, and the persons directly concerned sought out. As might be supposed, a very large proportion of the stories received were either wholly or partly ficti-

tious, or else grossly exaggerated. The writer's experience in collecting evidence in the United States for the society has been that from eighty-five to ninety per cent of all the stories received were not in accordance with fact. Some appear to be absolute inventions, but the vast majority are made up of a halo thrown by vivid or excited imaginations around some very commonplace occurrence. In one case, General O. O. Howard was given as authority for a very remarkable case of apparition at the moment of death. Names and dates were given with great exactness, and the story was followed up with interest. The result proved that neither General O. O. Howard, nor any one of several others of the same name, who were applied to under the supposition that the initials were wrongly given, knew anything about the alleged occurrence.

This sifting process is in itself valuable, for it places in the realm of fiction much of the current spiritualistic literature, and the attention of the society is concentrated on the residual and duly substantiated phenomena. Moreover, it must be borne in mind that science demands an answer to its questions, and has no regard for the character of the answer. So an answer "No" to a scientific query is of quite as much scientific value as an answer "Yes," though it may fall far below the latter in interest. A fact gained counts one, no matter whether it is positive or negative.

The second method pursued in these investigations has yielded more exact and interesting conclusions than the one just mentioned. The society has directly experimented with persons supposed to possess the power of thought-reading, mesmerizing, and hypnotizing, and as a result has accumulated a great mass of very valuable information.

The committee charged with the investigation of thought-reading, or *thought-transference*, as the society prefers to call it, has undoubtedly made the most progress up to this time. Phenomena falling under this head were divided into four classes: (*a*) where some action is performed, the hands of the operator being in gentle contact with the subject of the experiment; (*b*) where a similar result is obtained with the hands *not* in contact; (*c*) where a number, name, word, or card has been guessed and expressed in speech or writing, without contact, and apparently without the possibility of the transmission of the idea by the ordinary channels of sensation; (*d*) when similar thoughts have simultaneously occurred, or impressions been made, in minds far apart. Of these classes, (*a*) and (*b*) are set aside entirely, for, as has been shown by Dr. Carpenter and others, unconscious muscular actions and unconscious and almost imperceptible indications of various kinds account for any results obtained in these ways. With (*c*) it is very different. Here, to be sure, collusion and risk of error are very difficult to guard against, and in a general company would almost certainly be present. But it is otherwise if repeated experiments be made by a limited number of scientific men well known to

each other. It was in this way that the society's experiments were conducted.

The most satisfactory results were obtained from the family of a Mr. Creery, a clergyman in Derbyshire, four of whose children—girls whose ages ranged from ten to seventeen, thoroughly healthy, and as free as possible from morbid or hysterical symptoms—were reputed to possess the power of being able to designate correctly, without contact or sign, a card or other object fixed upon in the child's absence. To this family the committee made several visits of several days' duration, and the record of their numerous experiments appears to be absolutely unexceptionable and conclusive, as far as it goes. The active members of this committee were Professor Barrett and Messrs. Gurney and Myers.

Sometimes the inquiry took place at Mr. Creery's house, sometimes at the lodgings of the committee. Their plan was to select at random one child, who was then asked to leave the room and wait at a distance, while they chose a card from a pack, or wrote on paper some number or name which occurred to them at the moment. Sometimes, though not invariably, this was shown to the members of the family present in the room ; but no one member was always present, and on many occasions the members of the committee were entirely alone. The child was recalled, it having been made certain that she was at some distance when the number or card was selected. This, too, was an unnecessary precaution, as the habit was to avoid any utterance of the chosen card or name. The child was simply told before leaving the room, "This will be a card," or "This will be a name," as the case might be. On re-entering, she stood in any position she chose, though sometimes, at the committee's direction, with her face to the wall. She was silent for a period ranging from a few seconds to a minute, and then called out some name or number, or whatever the subject chosen was to be. If her answer was correct, the committee said "Right," if not, "No," and a second and sometimes a third trial was allowed.

In the case of a card, the chances are fifty-one to one against the successful guessing of any particular card, assuming that there is no such thing as thought-reading, and that errors of experiment are avoided. Yet, in one case of fourteen trials, *nine* were guessed rightly the first time, and only three trials can be described as complete failures. Some of the trials that resulted in what may be called partial successes are extremely interesting, and we give a short selection from the committee's record. The card selected is given in italics, the guesses in Roman type, and the only remarks made (those of the committee) in parentheses :

Five of clubs. King of hearts (No). Five of clubs (Right).
Two of spades. Two of spades (Right).
Three of spades. Three of hearts (No). Ace of spades (No).
Eight of spades. Eight of clubs (No). Eight of spades (Right).

Knave of hearts. Knave of hearts (Right).

Two of clubs. Two of clubs (Right).

King of spades. King of clubs (No). Knave of clubs (No). King of diamonds (No).

Knave of diamonds. King of diamonds (No). Knave of diamonds (Right).

It will be noticed that often the number of the card is guessed rightly, but not so the suit, and *vice versa;* and these partial successes are perhaps destined to be as important in drawing conclusions from the phenomena as those in which the guess was completely successful. In the above cases, the partial successes would seem to suggest a *mental eye,* so to speak, whose vision was in these cases obscured and inaccurate. Other cases, when the objects chosen were names, such as the guessing of Jobson for Johnson, would in a similar way suggest a *mental ear.*

As the result of six days' investigation with this family, 382 trials were made. In the cases of letters of the alphabet, of cards, and of numbers of two figures, the chances against success in a first trial were, of course, 25 to 1, 51 to 1, and 89 to 1 respectively; in the case of surnames they would be indefinitely greater. Cards were most frequently employed, and the odds in their case may be taken as a fair example. If this be done, then, in 382 trials, 7½ would be about the average number of successes on a first trial by an ordinary guesser. In these tests of the committee, 127 trials were successful on a first attempt, 56 on a second, and 19 on a third—202 in all.

The most striking success was when five cards in succession were named correctly on a first trial. The chances against this were considerably over one million to one. By way of precaution, the committee says in its report: "The phenomena here described are so unlike any which have been brought within the sphere of recognized science as to subject the mind to two opposite dangers. The hypotheses as to how they happen are confronted with equally wild assertions that they can not happen at all. Of the two, perhaps the assumption of an *a priori* impossibility is, in the present state of our knowledge of nature, the most to be deprecated, though it can not be considered in any way surprising."

We have given the data of this Creery case at some length, because it illustrates so admirably the methods of the society and the phenomena which it is investigating. In this and similar investigations, the question which the committee had before it was this: Is there, or is there not, any existing or attainable evidence, that can stand fair physiological criticism, to support a belief that a vivid impression or a distant idea in one mind can be communicated to another mind without the intervening help of the recognized means of sensation? And, if such evidence be found, is the impression derived from a rare or partially developed and hitherto unrecognized sensory organ, or has

the mental percept been evoked directly without any antecedent sense-percept?

Space will not permit me to more than mention the nature of the evidence which the society has collected for the purpose of answering these questions. Experiments have been made, and repeated again and again in order to reduce to a minimum all chances of collusion and error. Sometimes contact between the agent and the percipient has been permitted, and sometimes not.* Much of the evidence is very remarkable, but must be read in its entirety to have its full effect, and we refer any inquiring reader to the full reports of the various committees as published in the proceedings of the society.

As a scientific result, the committee felt justified in drawing up the following: 1. That much of what is popularly known as "thought-reading" is, in reality, due to the interpretation by the so-called "reader" of signs, consciously or unconsciously imparted by the touches, looks, or gestures of those present; and that this is to be taken as the *prima facie* explanation whenever the thing thought of is not some visible or audible object, but some action or movement to be performed. 2. That there does exist a group of phenomena to which the word "thought-reading," or, as the committee prefers to call it, *thought-transference*, may be fairly applied; and which consists in the mental perception, by certain individuals at certain times, of a word or other object kept vividly before the mind of another person or persons, without any transmission of impressions through the recognized channels of sense.

Concerning these phenomena, Mr. Myers writes: "We have got, as we hold, a definite fact to start from—a fact of immense and unknown significance. If, as we believe, we can truly say 'mind acts on mind otherwise than by the recognized organs of sense,' this is probably a statement far more pregnant with consequences than the statements, 'rubbed amber attracts straw,' or 'the loadstone attracts iron.' And it must be our business to turn our new fact over in every direction, to speculate upon it in every way, or, rather, in every way which can possibly suggest a new form of experiment. We must remember that the experimental cases which we have already collected are probably only what Bacon calls 'ostensive instances'; 'instances,' as he expresses it, 'which show the nature under investigation naked, in an exalted condition, or in the highest degree of power; and which are, so to speak, mere emergent summits from a great ocean, which lies beyond our present reach of observation, and, perhaps, even beneath the level of our consciousness.'"

As might have been supposed, most progress has been made in this field of thought-transference, for its phenomena are the simplest, and

* The agent is the technical name for the person who concentrates his thoughts upon the chosen object, and the subject or percipient is the person who "reads" the thought, and tells what the object thought of is.

most readily admit of verification or disproof. Still, something has been accomplished in each of the six departments of investigation. The committee having in charge the Reichenbach experiments felt justified in making a report about three years ago, of which the following is the tenor: 1. That three observers separately, on distinct occasions, were in some way immediately aware when an electro-magnet was secretly "made" and "unmade," under such precautions as were devised to prevent ordinary means of knowing, and to exclude chance and deception; and the observers identified such magnetization, with luminous appearances, which, as described, agreed generally with the evidence recorded by Reichenbach. 2. That there were, though less decisively, indications of other sensory effects of magnetism. In view of these apparent confirmations of previous testimony, the committee inclined to the opinion that, among other unknown phenomena associated with magnetism there is a *prima facie* case for the existence, under conditions not yet determined, of a peculiar and unexplained luminosity resembling phosphorescence, in the region immediately around the magnetic poles, and visible only to certain individuals.

The committee on haunted houses has carried on widely extended investigations, despite the fun which the public prints have poked at its "ghost directory," but as yet has not made sufficient advance to warrant a report. It will strengthen our confidence in this committee's work if we recollect that it holds that the unsupported evidence of a single witness does not constitute sufficient ground for accepting an apparition as having a *prima facie* claim to objective reality. Under the operation of this rule, ninety-five of every hundred ghost-stories must fall to the ground.

The investigators of mesmerism are undoubtedly working in a field which has been by no means neglected in the past. They, therefore, have more definite lines of guidance than most of their colleagues. We find that they divide the main phenomena connected with the mesmeric state into three classes: (1) the dominance of a suggested idea; (2) transference of sensations, without suggestion, from operator to patient; (3) induction of general or local anæsthesia. Of these classes the committee pronounces that the first is on the high-road to universal acceptance; that the second is rarely contested, but the committee has added something to the facts already recorded in its favor, and has hope of adding more; that the third class—the production of anæsthesia—has already been established by overwhelming evidence, and is to a certain extent admitted by modern physiologists. But it remains undecided whether this anæsthesia is produced by mere expectant attention, exercised in a particular state of the nervous system, and is thus the culminating example of the dominance of a suggested idea; or, whether it is the result of the inhibition of certain sensory centers in consequence of prolonged stimulation of the peripheral ex-

tremities of the nerves; or, whether it is the result of some specific effluence from the operator, which may act without actual contact, independently of the subject's knowledge or expectation. On the whole, the committee's evidence leans toward the last and antecedently the least probable explanation. But as yet no definite answer is possible on this point.

The literary committee has done very important work, for, in addition to the collection of a considerable library of books on psychical subjects, it has more than one hundred cases, with the evidence taken at first hand, of apparitions closely coinciding with the time of the death of the person seen; and it is only in a small minority of such cases that informants, according to their own account, have had any other hallucination than the apparition in question. While no deduction from this evidence is yet justifiable, yet we may safely agree with Professor Balfour Stewart when he says that "the great importance of this statement will be manifest to all."

There the work stands at present. We have given a brief outline of the objects and method of the society, and have endeavored to make clear just how far its work has progressed. The society is actively at work, the literature of the subject is increasing, and at no distant period more definite conclusions may be laid before the scientific world, and the supporting evidence given at length. That the interest in this work is general is proved by the formation of societies for psychical research in Boston and Chicago, and the character of their officers and conductors is, as is the case in the parent society in England, surety for the careful and scientific prosecution of their investigations. In France too, the psychologists are turning their attention to these phenomena, and men like Janet, Ribot, and Charcot are at the head of a society similar to those we have mentioned.

So far the results are certainly indefinite, but they are interesting and suggestive. The time may soon come when we shall either be able to speak definitely and accurately about these abnormal phenomena, or else to say on demonstrable grounds that their causes and laws lie beyond the limits of human knowledge. Whatever we know will be incorporated in the vast body of scientific truth, and the *raison d'être* of a small army of frauds and impostors, as well as of innumerable superstitions, will have been swept away.

CAUSES OF THE PRESENT COMMERCIAL CRISIS.

By PAUL LEROY-BEAULIEU.

THE whole world has been suffering for two years under an intense commercial crisis. Hardly any country has escaped the stringency. For special reasons, France has suffered the most. But England, Belgium, Italy, Germany, and even the United States and the

South American republics, have not been free from its effects. All kinds of commercial activity bear witness to a universal languor. The railroads show diminished receipts over all the European Continent and in the British Islands. The foreign commerce of France has been declining for five years, during which time the valuation of imports has diminished by sixteen per cent, and that of exports by ten and a half per cent. A part of this decrease is, doubtless, due to the general depreciation of prices, so that the falling off in the quantity of goods handled is not actually so great as the figures would make it appear; but this depreciation in prices is another cause of serious concern to economists. England, also, is struggling against difficulties of a similar character. Italy, where the financial management in later years has been most excellent, has had to pay tribute, though in smaller proportionate amounts, to the general depression. Germany has met a check in the speedy race to wealth which it proudly thought it was making. In the United States the exports have fallen $200,000,000 since 1880. The Argentine Republic, also, is obliged to struggle against grave financial and commercial embarrassment.

We may consider, then, that all nations are afflicted with commercial depression. What are the causes of this universal debility? How long will it last? What remedy can we employ to restore commercial health in the shortest possible time? The opinions as to the origin of the crisis are widely different. Some persons see in it only one of the periodical shocks, one of the "growing pains" which seem to be the accompaniment and price of all progress, and which, coming on in the natural course of events, and having a kind of character of fatality, will disappear of themselves. And some of the people of this class believe they can already see the signs of convalescence. Another class of observers pretend that the present crisis is different from any that have preceded it, that its cause is not natural but artificial, and originated in the mistakes of governments, and that a simple, easily adopted measure of policy will cause its removal at once. These are the partisans of silver, or the bimetallists, as they call themselves. Some attribute the trouble to over-production. Men are producing more than they need. If we do not raise less wheat, make fewer clothes, build fewer houses, everybody will die of hunger, or cold, or want of shelter. This is not a new doctrine, self-contradictory as it is. Then come the protectionists. The mischief is on us because we do not protect enough. All countries are suffering because they buy too much and sell too little. We must protect more. When all the different lands shall have realized that mysterious ideal of selling much to one another without buying in their turn; when they shall, by means of customs duties, have annulled the diversities of productive forces that are derived from nature or from remote antecedents; when they shall have abolished the territorial division of labor among men—the fine days will come again, and prosperous years will

follow one another without interruption. Let us examine these various opinions in succession. We first take up those of the silver partisans; but, without entering into a scientific discussion of the questions at issue, we shall only speak of the actual influence of recent monetary facts on the price of goods and on commerce. There were till recently two metals, sometimes rivals and sometimes allies, contending for and occasionally sharing the monetary function of the world—gold and silver. Each of them had its peculiar territories, and they sometimes spread over into common territories. Gold reigned in England, the United States, and the Scandinavian countries; silver, in the Indies and Germany, and nominally in Austria and Russia; while both metals had undivided sway in France, Italy, Switzerland, Belgium, and Greece, or the countries of the Latin Union, where they had equal legal rights, and were rated in value at fifteen and a half by weight to one—a valuation which M. Cernuschi calls the bimetallic par. This par exists only in some countries, not in all. After the war with France of 1870–'71, Germany changed its single silver standard for one of gold. The Scandinavian states followed suit. France was restrained from following this example by the resistance of the Bank of France, which foresaw ruin to itself in such a measure. The initiative of Germany—although it had failed to make the demonetization of silver complete, as it had intended—coincided with a profound change in the monetary situation of the world. The metal silver began to depreciate and to grow less in value relative to gold. The countries of the Latin Union, being the only ones in which the two metals enjoyed a *condominium* at a ratio of values fixed at the beginning of the century, took alarm at these signs of a widening of the difference in values, and adopted an exclusive standard of gold. The depreciation of silver continued, at an accelerating rate, till, in 1885, it took 18·63 grains of that metal to be the equivalent of one grain of gold. Silver had lost nearly twenty-one per cent of the value which it had maintained, as a rule, till 1871. At the present writing the depreciation has reached twenty-two per cent. This depreciation is regarded by MM. Laveleye, Cernuschi, and De Soubeyran, as the result of the demonetization of silver by Germany and the Latin Union; but this demonetization, only partial in Germany, was merely an incident in the matter, and inadequate to produce so great an effect. A much more important factor is the increase in the production of silver, which has been enormous during the last fifteen years, accompanied by considerable reductions in the expense of the processes for extracting it, the effect of which is also intensified by a greatly diminished production of gold. With a tripled production of silver, which the statistics show to have taken place, and a reduction of one third in the amount of gold, also proved by the statistics, we need go no further to find the explanation of the change which has taken place in the relative value of the two metals. From 1851 to

1855 the value of gold produced exceeded that of silver in the proportion of seventy-seven and a half to twenty-two and a half; in 1884 the proportions were reversed, and the value of the silver produced was to that of the gold as fifty-seven to forty-three.

The question now arises whether the relative rarity of gold has been adequate to exercise a sensible influence on prices and on the commerce of the world as a whole. Many writers insist that the two phenomena are connected, because they are simultaneous. It is also worthy of remark that the production of gold fell off at the very time when a considerable number of nations turned to that metal as the basis of their monetary circulation; when the United States and Germany resumed specie payments in gold and Italy began to hoard it. The reasonings of these persons contain some facts mingled with conjectural inductions. Times of commercial crisis are always characterized by depression of values. In making our comparisons we should be careful to set off ordinary years against ordinary years, and not let peculiarly exceptional years, such as sometimes occur, slip into one side of the comparison to exaggerate the apparent difference. The depreciation of values, moreover, which is spoken of now, is not universal; but many articles have escaped it, or have been only feebly affected by it. A considerable number have held their own, or have risen in price, during the past twenty-five years. Tin has fallen but slightly; the same is the case with soap and bottles. In alimentary products the great depreciation which is talked of is hardly visible, except in wheat, coffee, and sugar. Salt, beer, butter, and pepper have risen. Meat falls but slowly, if at all, and hides are dearer than they were between 1861 and 1870. Through the list as a whole, the tendency to depreciation, it is true, is dominant, but the exceptions are numerous and important. When we turn to human services, of whatever kind, whether professional or those of common laborers, we find that salaries and wages have risen all around. Now, if the cause of the present crisis were the increase in the value of gold, the prices of everything, without exception, would have fallen. They have not done so, and we must look for other causes. If we look without prejudice, they will not be hard to find. Two conditions may be discovered existing in combination in the cases of all articles the price of which has fallen—that the production has become remarkably more abundant and the expenses of it have notably diminished. We find both these conditions existing in wheat, cotton, coffee, iron, cast-iron, copper, and everything else that is cheaper.

The amount of territory in cultivation in wheat has increased enormously: in Europe, thirty-four per cent in less than thirty-five years; in the United States, by nearly tripling in thirty-four years and doubling in fourteen years; in the British colonies outside of India, nearly as much. Contrary to the predictions of Malthus and Ricardo, the last quarter of a century has seen food-substances, through the whole

civilized world, multiplying much more rapidly than the population. M. de Neumann-Spallert, a statistician of high reputation for accuracy, has shown that the trade of the civilized world in cereals more than doubled between 1869 and 1879. Since then it has suffered a slight recoil. The production of cotton, which was estimated at 1,192,000,000 pounds in 1840, and 2,474,000,000 pounds in 1860, remained nearly stationary—increasing only about three and a half per cent—between 1860 and 1870, on account of the American civil war; but between 1870 and 1880 the crop of the United States rose from 1,540,000,000 to 3,161,000,000 pounds, and the crop of the whole world to 4,039,000,000 pounds, showing an increase of about sixty-seven per cent in ten years. But this is insignificant by the side of the increase that has been realized in the production of wool. A commercial circular, issued by one of the principal brokers of Antwerp, has recently established in the most striking manner the relations of the price to the quantity of wool imported into Europe. Taking into consideration the stocks of colonial wools coming from the three principal producing countries, Australia, the Cape Colony, and La Plata, we shall find that in 1864 the importations amounted to only 458,000 bales; in 1868 they had nearly doubled, and reached 879,000 bales. The price then fell to one franc eighty-five centimes (about twenty-five cents), and for a short time in 1869 to eighty-five centimes (or about seventeen cents), the lowest price that had then been known. For five or six years the importations remained stationary, or only increased a little, and prices stiffened. But in 1877 the importation was much more considerable, amounting to 1,272,000 bales, or forty per cent more than five years previously, and prices fell in nearly a corresponding proportion. For the next two or three years the colonial importations were stationary, and prices rose. But the increase in production was resumed; the importation of wools into Europe was estimated at 1,740,000 bales in 1885, and prices descended correspondingly.* A considerable increase, though not so great, has taken place in the production of coffee, which has risen from 321,000 tons in 1855 to 588,000 tons in 1881, or sixteen per cent. This is not very great, but the increase in the use of coffee is still slower. The production of sugar has increased more rapidly. The increase in the production of cane-sugar in 1882 amounted to about one third in five years, and that of beet-sugar in 1883 to forty per cent in three years. Since these dates the production seems to have taken a new start.

A glance at the statistics of metal-working ought also to convince a reasonable man that the cause of the fall in prices should be sought in the conditions of the production of each article. Fine copper is one of those metals which have fallen most within fifteen years. The production of it, which was only 45,250 tons in 1850, and 67,370 tons in 1860, reached 82,120 tons in 1870, and over 120,000 tons in 1880,

* See this circular in "l'Économiste français," February 7, 1886.

and this figure was passed in the following years. The case is not different with lead, the production of which, 104,000 tons in 1830 and 170,500 tons in 1850, passed 379,000 tons in 1880, or was more than doubled in thirty years. The production of iron has doubled in ten years, and that of coal increased about 145 per cent in twenty years.

We might pursue this enumeration almost to infinity. If, however, instead of studying the special and precise cause of the depression in the price of each article, we seek the more general causes, they are easy to find. The question of the metal silver is foreign to them. The general causes may be reduced to the following: The whole world is much better explored than it was twenty years ago, and all the natural riches, the best lands, and the best deposits, are better known. Capital, having become more abundant, is more mobile and more active, bolder, more ready to change places, and more transportable than it was a quarter of a century ago, so that the simple announcement of the discovery of a new source of wealth at any place in the world almost immediately induces attempts to make it available. The rise of anonymous business societies, or companies, has an importance of which we are hardly yet beginning to take account; the substitution of this powerful collective force for the molecular forces of personal and isolated capital has transformed and sometimes decupled the efficacy of investment. Men also have become less sedentary, and eagerly follow their capital wherever it calls them and promises them remuneration. The progress of industry, manifested by inventions, discoveries, improved processes, and even workmen's slights, is contributing daily to this incessant development of production and cheapening of prices. The last factor, and not the least energetic one, is the improvement of the means of transportation, especially by sea, during the last fifteen years, by virtue of which it is calculated that every English ship can now carry twice as much freight as in 1870, three times as much as in 1860, and four times as much as in 1850.

These are the general and incontestable causes which have acted, and are continuing to act, upon the provisioning of the world. To seek the explanation of the fall of prices anywhere else is willfully to close one's eyes. It is vain to pretend that the fall of silver, which amounts to twenty-two per cent of the value given it in our monetary tariff, gives the Indies an advantage in exportation. Amid phenomena so vast and striking, this is only an insignificant detail. The greater part of the goods which have drooped in price are not produced in countries having a silver standard. The great marts of production of copper, for example, are not in the East, but in the West—in Spain and the United States. So with iron and with wool, which is peculiarly the product of countries having a gold standard. Sugar and cotton, also, are most largely produced in countries where the fall in silver can have no direct influence.

It would be well if we could come to an understanding of the real

effect of a depreciated currency upon the external commerce of a large country. It is often asserted of India that the depreciation of silver has given it a great advantage, because it can sell its goods at a price which calculated in gold would be less than that charged by competing countries; but, on the other hand, nearly all the finance officers of India and England are suffering from the embarrassments inflicted upon the Indian treasury by this very decline. If we admit the principle that a depreciated currency is an advantage to a country, we should conclude that Russia is never more prosperous than when its ruble declines, the Argentine Republic and Brazil than when their forced paper loses another fraction of its nominal value; and that those countries, like Italy and the United States, which exerted themselves to pass from the *régime* of paper money and resume specie payments, committed a false step, because, in substituting a strong and stable currency for a weak and variable one, they made exportation more difficult. It may be acknowledged that a slow and gradual depreciation of the value of money may at first aid to a certain extent in the development of exportations. But this is only a transitory phenomenon. All prices will soon come to a level, and salaries and wages will rise; and the temporary advantages accruing to producers and exporters will vanish. If the foreign commerce of India has sensibly expanded within the last fifteen years, we can point out more palpable, precise, and certain causes for the increase than the fall of silver, in the development of the network of railways, the operation of the Suez Canal, with the continual reductions in its tolls, and the cheapening of marine freights. Railroads and steamboats are the great levelers of prices. Add to these the effect of all the improved processes for loading and unloading, such as grain-elevators and all the new port facilities, and we shall find in this whole of circumstances so varied and yet so concordant a cause for the cheapening of goods much less problematical than the depreciation of silver.

There is another consideration to be taken account of when we refer the fall in prices to the diminished production of gold. It is not correct to suppose that it is indispensable for the maintenance of prices that the quantity of the precious metals which form the standard shall be increased in proportion to the extension and volume of commerce. Numerous recent discoveries contribute to permit economy in the circulation of the precious metals. Submarine telegraphs, for example, more exact knowledge of the ocean-currents, the cutting of isthmuses, and improvements in the steam-engine are diminishing the use of these metals in international commerce. If we wish to send a million dollars in bullion from America to England, it will only take six or seven days now against the twelve or fifteen days that it took twenty years ago. Specie can be sent now from Australia to Great Britain in thirty-five days, where it took ninety days a quarter of a century ago. This shortening of the time required for the trans-

mission of gold is really equivalent to an increase in the available quantity of it. Furthermore, the methods of payment by balances between one market and another have become more varied and abundant. The simple development of international credit permits us to transfer funds from one country to another without a grain of gold being moved. Bank-notes circulate among all classes of the population in all countries, and checks have become everywhere a more usual means of payment. Piled up in the great banking-houses, the precious metals suffer less diminution by wearing, by material loss, and by hoarding. The whole world is thus managing to make less and less actual use of metallic money. To all the causes of decline we have passed in review may be added another cause, accidental and temporary, but effective while it continues in operation—the check to speculation. Speculation is as necessary to commerce as Achilles was to the army of the Greeks. It is that which gives life to trade, sustains prices, and fills the heart with hope. Without it everything languishes.

The reader may now be ready to infer from this review that an excess of production is the cause of the crisis. We are producing too much, and mankind is poor because of its wealth. Men are troubled to get enough to eat, to dress themselves, and to find lodging, because we are producing too much food, making too many clothes, and building too many houses! It can hardly escape any one that this explanation, when presented in this straightforward way, has a queer look. Have we really produced too much? Can we produce too much? At any rate, can it ever happen that an excess of production will engender misery? Such an hypothesis, at least in respect to the production of articles of subsistence, can hardly be admitted. Humanity has so many wants, natural or artificial, that it will never be satisfied, and we shall always have work to do for it. The old needs are extensible, and new ones are arising every day. When the man is warmly clad and he can not put on more clothes without loading himself down, he thinks about putting carpets on his floors and pictures on his walls. Consumption has unlimited appetites. It may, however, be admitted that there can be over-production of particular articles. Some humorous fellow, for instance, has suggested that we might make too many coffins, and, be they ever so cheap, the demand for them would not increase. But even in this case, perhaps, the taste would be stimulated for finer and more expensive coffins, and manufacturers would still have something to do. So there are a few other articles of which the number or quantity capable of being made useful is limited, but the quality of which is capable of indefinite expansion. In articles of personal use, like shoes and clothing, more abundant production and cheapening are apt to have the effect of causing us to change them often and to be more careless about having them repaired, and thus open the way to a larger demand for them. There are also articles not essential, but serving as instruments of

labor of which there might be too many made. We might conceive of an excess of needles, or of looms, or spinning-wheels, or locomotives, or steamboats. But these are exceptional cases. Of most of the articles that are made for direct consumption we may say, as a rule, that they can not be offered in absolute excess. The world is never likely to have too much cloth, or sugar, or coffee, or meat, or wheat, or even too many houses. A great many people in comfortable circumstances, to say nothing of those who are poor, would have many more carpets and paintings, would use more sugar, would take coffee more frequently, would eat more meat, and enjoy more costly food, and would live in better houses, if it were not for the expense and for the habits they have already formed under the restraint of the cost of living. There can not really be an excess of any of these articles. If the supply is at any time in excess of the demand, it is not because this is not capable of increase, but because the increase is restrained for the time by circumstances which will prove to be only transitory. Take the case of houses in Paris. They say there have been too many built. Too many, it is true, for the builders to sell immediately at a profit ; but not too many for the population who are all the time complaining of being lodged in too close quarters, and would gladly exchange their two rooms for three, and their three for four or five, if they could afford it.

We sometimes say of children or young people that they have grown too much. The expression is inexact, for we do not mean that we should wish to see them smaller again ; but we mean that they have grown up so quickly that their bodily functions and their carriage have not had time to adapt themselves to the new and unaccustomed size. The case is very similar with what we are accustomed to call crises of over-production. Taken in a general sense, this expression too is inexact. We must not conclude from its use that men should try to go back and produce less. It is only a "growing-pain," the result of a useful phenomenon being produced too abruptly, before there has been time to modify habits, establish new agencies, and adapt society to the new conditions, which operations have to take place gradually. Time and the course of events will furnish effectual remedies for the momentary inconvenience.

We must be on our guard against the empirics and charlatans who are continually besieging the public powers of suffering nations. First among these are the protectionists. "The world," they say, "is producing too much ; we have to struggle against universal competition. We have the remedy in our hands. We must proscribe foreign goods and encourage our own." This kind of reasoning has lately come into new credit. Nothing can be more unreasonable. Protectionism is, in fact, largely responsible for the present crisis. Let us judge of its effects by a few examples. Among the articles that are most largely produced and have suffered the greatest decline in price

are steamboats, railroad-iron, metals, and sugar. These very articles are the most highly protected ones in nearly every country. Too many steamers have been built, and freights have fallen below a paying price. What is there strange about that, when England has gone into the business with all the acquired advantages and prestige of her maritime supremacy, and most of the other nations are encouraging the building of ships with all their might by means of direct appropriations, differential duties, subventions, or special postal privileges? To make the disproportion still greater, protectionism is now at pains to reduce as much as possible the amount of freight which this surplus of ships will have to carry. By its discriminating duties, it tries to restrict, or even completely to prevent, the importation of foreign goods. If you will have a marine, and go to the extent of subsidizing it, you ought to have something for it to carry. Now, it can carry nothing but goods coming from abroad or going abroad. The protectionist policy of most of the countries practicing it can be reduced to the maxim, "Get by means of subsidies and prizes, as large a marine as possible, and secure for it, by protection and prohibitory duties, as little freight as possible"!

The deplorable effects of the protectionist *régime* are no less evident in general metallurgical industries. Protection is given everywhere by means of extravagant duties. In France, the duties represent from fifty to sixty per cent of the current value of the goods. Yet these industries are among those that are languishing the most. This is because the effort has been made everywhere by means of customs duties to stimulate them to excess. In the United States, Russia, Austria, Italy, Spain, and France, the people have been persuaded that they can not build enough furnaces and machine-shops; and the result has come about that Spain has by great exertions succeeded in sending a locomotive to England, the very home of steam-engine making, for sale. All countries are taxing their ingenuity to build up their export trade. Formerly this was the branch of business which returned proportionately the most profit; now it returns the least.

In no industry does the absurdity of the protectionist system make a clearer exhibition of itself than in the trade in sugar. France, Germany, Austria, Italy, Belgium, Holland, and Russia, are each laboring to make their national sugar industry the greatest in the world. Each of them gives premiums, by ingenious devices, upon exportation. The consequence of their efforts is, that this sugar industry, the object of extraordinary favors, has gone entirely astray from its natural ways. Production is pushed everywhere. The cost price is not considered, but only the export price; and the point has been reached that so much sugar is made in every country that the price is going down every day. Governments are induced by this fact to increase their favors, and then the price takes another fall.

While it has a less palpable influence in the generality of cases, the

protectionist policy is not less unfavorable to industry as a whole. If the market for most of our export products is restricted, one of the causes for it is to be found in the fact that between 1878 and 1880 France converted most of the nations to protectionism; we set them the example and they followed it. We repel foreign wheat, cattle, and cotton-thread, and they repel our *articles de Paris*, silks, furniture, and wines. The principal factor in the disproportion between the production and consumption of certain articles is the customs tariff. It acts in two ways: by depriving the export trade of the markets to which it has been accustomed, and by stimulating new manufactures which are destined in their turn to find no market. Finally, commercial treaties having no longer a real existence, because they are almost reduced practically to a clause conferring no fixed rights—the most-favored-nation clause—there results a great instability in tariffs, and consequently in international relations.

Another factor of the crisis may be found in the extravagant public works undertaken by states. The whole European Continent and some distant countries have plunged up to their ears in vast enterprises which are supposed to be of public utility. The thought that great works can not be indefinitely carried out, that their efficacy is limited, that beyond a certain point they do harm to one another, and bring no more aid, no durable stimulus to industry, simple and true as it is, has become strange to the light heads that rule parliamentary countries and democracies. A large country may derive much profit from half a dozen first-class ports; but what real advantage can come from turning the thousand creeks which indent the shores into ports? It would be about the same thing if a man, instead of having one or two outside doors to his house, should cut up his whole first floor into doors. The case is the same with roads and canals. Beyond a certain extent, they serve no other purpose than to withdraw the land they occupy from cultivation. In a country of 500,000 square miles, the first 20,000 miles of railroad are very useful; the next 5,000 miles much less so, while 5,000 miles more would be an excess, a luxury to which we might perhaps afford to apply our surplus profits, but which it would be foolish to pay for out of the capital fund. Every new mile of railway opened in France produces a small income, but three fourths of it is simply so much revenue diverted from other roads, and not the product of a new traffic. This unreasoning activity in constructing useless public works which prevails in many countries adds at once to the burdens upon industry and to its instability. It has contributed to withdraw masses of laborers from the regular cultivation of the soil, to cause abrupt rises of wages, and to make workmen more exacting and more refractory to discipline; it has given a factitious development to metallurgical industry, and it has cast disorder into budgets, hollowed out deficits, necessitated enormous imposts, and increased public debts or postponed the day when they will be paid.

Many light heads are still eager to come to the relief of suffering workmen by modifying legislation and opening mines. If these counselors would take the trouble to reflect, they would see that all intervention of the state in the economical domain is essentially disturbing. It is an element of instability, disorder, and waste. With their customs laws which they are constantly making and unmaking; with the changes with which they threaten mining property, sometimes funded property; the free exercise of industries and the freedom of contracts, with the inconsiderate public works they undertake; the loans they contract; the new places they create, and the parasitism they develop, governments, while they are no more useful than flies on a carriage-wheel, count for a great deal in the existing economical crisis. They contributed to bring it about, and they are contributing to prolong it.

For a permanent cheapening of the cost of production a third factor should be reckoned upon—improvement in workmanship. It would be puerile to ignore the fact that the workmen of Western countries, well endowed as they are in other respects, have become infatuated with the new conditions of their life. A too rapid increase of wages, superficial instruction, the sudden possession of political and civil rights which their fathers had not, concentration in cities with a corresponding withdrawal of workmen from the country, all together have contributed to exalt the conceit of a great number of workmen, and especially of their leaders. The results are a seeking for extravagant wages, habits of partial idleness, and a general looseness in the matter of days' works. It would no doubt be a most desirable consummation if the general condition of mankind were such that we could pay even unskilled laborers such wages as they are sometimes able to command in the great cities. But it is not the case. In the world at large nine tenths of the industrious classes are at a long distance from such conditions. Western workmen, especially in the United States, England, and France, forget that by reason of exceptional circumstances they constitute a kind of aristocracy of labor. Like all aristocracies, they have at last given way under their exaltations to the point of losing the taste for labor and the practice of doing their work conscientiously; and their leaders are trying to draw them still further away from the feelings and habits which enter into the make-up of the good and solid workman. Western civilization is incurring a great peril from this source. When China is fairly opened to the world and has become a country of railroads and factories, it will become necessary to make a new adjustment of wages and holidays all over the world, as has already been done with the prices of goods. The exceptional wages of the day, and the two or three "off days" a week, can not survive the approaching competition of the extreme East. The reform that it is desirable to make should not await the coming of this imminent event, or the conversion may be too late. As capitalists have been obliged to accept the situation and resign themselves to a gradual

diminution of their profits, so workmen, the unfaithful ones at least, among Western peoples, will have to recover the habits of regular and conscientious work, which were formerly in honor, but upon which they are now trying to cast discredit. Possibly, most of the additions to wages that have been made in later years will have to be reduced; but this will be compensated for by the greater regularity of work and the general cheapening of the necessaries of life.

In addition to the factors we have described, a new arrangement of commercial agencies is needed to the full bringing about of the equalization of consumption with production. In most countries the economical organism is complicated with superfluous wheels. The curiously abnormal situation is presented that, while the producer gets lower prices, the consumer pays no less. The number of middle-men also grows quite as fast as the difference between wholesale and retail prices, so that they too make no great profits. Two evils results from these conditions: many persons are lost from work on the farm or in the shop; and the consumer, not profiting or profiting but little by the cheapening of prices, does not extend his consumption. No equilibrium can be established between a production that is increasing and a consumption that remains nearly stationary. The state has no part in this situation; but producers and consumers sin by indifference to one another; and the remedy for the result should be brought about by their joint action in creating market depots at which they can be brought into more direct relations. The state may best facilitate such arrangements by leaving the parties at perfect liberty. Its interference in any way would be a blunder, and only a hindrance to the accomplishment of the desired end.

The present crisis has a much more general character than any of the crises that have preceded it, because it is a part of an abrupt transformation in the production and circulation of the whole world. For the same reason it is destined to last longer. Nevertheless, if governments have wisdom and foresight enough not to interfere with the course of events, an era of improvement may shortly begin. Those persons who occupy their minds with plans to induce interference by the state in the interest of labor and enterprise, whether by the purchase or establishment of works, stimulation by bounties, discriminating taxes, or by rules for the regulation of the relations between workmen and their employers, show more zeal than wisdom, and are asking what will only aggravate the evil. The action of the state in such matters is essentially disturbing, and can never be regulative. All that we should ask of it is not to interfere, but to retrench its own expenses, to contribute by economical administration to the reduction of costs of production, and by a calm and wise attitude to the revival of confidence.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

THE PHYSICAL LABORATORY IN MODERN EDUCATION.*

By HENRY A. ROWLAND, Ph. D.,
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FROM the moment we are born into this world down to the day when we leave it, we are called upon every moment to exercise our judgment with respect to matters pertaining to our welfare. While Nature has supplied us with instincts which take the place of reason in our infancy, and which form the basis of action in very many persons through life, yet, more and more as the world progresses and as we depart from the age of childhood, we are forced to discriminate between right and wrong, between truth and falsehood. No longer can we shelter ourselves behind those in authority over us, but we must come to the front and each one decide for himself what to believe and how to act in the daily routine and the emergencies of life. This is not given to us as a duty which we can neglect, if we please, but it is that which every man or woman, consciously or unconsciously, must go through with.

Most persons cut this gordian knot, which they can not untangle, by accepting the opinions which have been taught them and which appear correct to their particular circle of friends and associates; others take the opposite extreme, and, with intellectual arrogance, seek to build up their opinions and beliefs from the very foundation, individually and alone, without help from others. Intermediate between these two extremes comes the man with full respect for the opinions of those around him, and yet with such discrimination that he sees a chance of error in all, and most of all in himself. He has a longing for the truth and is willing to test himself, to test others and to test nature until he finds it. He has the courage of his opinions when thus carefully formed, and is then, but not till then, willing to stand before the world and proclaim what he considers the truth. Like Galileo and Copernicus, he inaugurates a new era in science, or like Luther, in the religious belief of mankind. He neither shrinks within himself at the thought of having an opinion of his own, nor yet believes it to be the only one worth considering in the world; he is neither crushed with intellectual humility, nor yet exalted with intellectual pride; he sees that the problems of nature and society can be solved, and yet he knows that this can only come about by the combined intellect of the world acting through ages of time, and that he, though his intellect were that of Newton, can, at best, do very little toward it. Knowing this, he seeks all the aids in his power to ascer-

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tain the truth, and if he, through either ambition or love of truth, wishes to impress his opinions on the world, he first takes care to have them correct. Above all, he is willing to abstain from having opinions on subjects of which he knows nothing.

It is the province of modern education to form such a mind, while at the same time giving to it enough knowledge to have a broad outlook over the world of science, art, and letters. Time will not permit me to discuss the subject of education in general, and, indeed, I would be transgressing the principles above laid down if I should attempt it. I shall only call attention at this present time to the place of the laboratory in modern education. I have often had a great desire to know the state of mind of the more eminent of mankind before modern science changed the world to its present condition and exercised its influence on all departments of knowledge and speculation. But I have failed to picture to myself clearly such a mind, while, at the same time, the study of human nature, as it exists at present, shows me much that I suppose to be in common with it. As far as I can see, the unscientific mind differs from the scientific in this, that it is willing to accept and make statements of which it has no clear conception to begin with and of whose truth it is not assured. It is an irresponsible state of mind without clearness of conception, where the connection between the thought and its object is of the vaguest description. It is the state of mind where opinions are given and accepted without ever being subjected to rigid tests, and it may have some connection with that state of mind where everything has a personal aspect and we are guided by feelings rather than reason.

When, by education, we attempt to correct these faults, it is necessary that we have some standard of absolute truth; that we bring the mind in direct contact with it, and let it be convinced of its errors again and again. We may state, like the philosophers who lived before Galileo, that large bodies fall faster than small ones, but when we see them strike the ground together we know that our previous opinion was false, and we learn that even the intellect of an Aristotle may be mistaken. Thus we are taught care in the formation of our opinions, and find that the unguided human mind goes astray almost without fail. We must correct it constantly and convince it of error over and over again until it discovers the proper method of reasoning, which will surely accord with the truth in whatever conclusions it may reach. There is, however, danger in this process that the mind may become over-cautious, and thus present a weakness when brought in contact with an unscrupulous person who cares little for truth and a great deal for effect. But if we believe in the maxim that truth will prevail, and consider it the duty of all educated men to aid its progress, the kind of mind which I describe is the proper one to foster by education. Let the student be brought face to face with Nature; let him exercise his reason with respect to the simplest physical phenomenon, and then,

in the laboratory, put his opinions to the test; the result is invariably humility, for he finds that Nature has laws which must be discovered by labor and toil, and not by wild flights of the imagination and scintillations of so-called genius.

Those who have studied the present state of education in the schools and colleges tell us that most subjects, including the sciences, are taught as an exercise to the memory. I myself have witnessed the melancholy sight, in a fashionable school for young ladies, of those who were born to be intellectual beings reciting page after page from memory, without any effort being made to discover whether they understood the subject or not. There are even many schools, so called, where the subject of physics or natural philosophy itself is taught, without even a class experiment to illustrate the subject and connect the words with ideas. Words, mere words are taught, and a state of mind far different from that above described is produced. If one were required to find a system of education which would the most surely and certainly disgust the student with any subject, I can conceive of none which would do this more quickly than this method, where he is forced to learn what he does not understand. It is said of the great Faraday that he never could understand any scientific experiment thoroughly until he had not only seen it performed by others, but had performed it himself. Shall we, then, expect children and youth to do what Faraday could not do? A thousand times better never teach the subject at all.

Tastes differ, but we may safely say that every subject of study which is thoroughly understood is a pleasure to the student. The healthy mind as well as the healthy body craves exercise, and the school-room or the lecture-room should be a source of positive enjoyment to those who enter it. Above all, the study of nature, from the magnificent universe, across which light itself at the rate of 186,000 miles per second can not go in less than hundreds of years, down to the atom of which millions are required to build up the smallest microscopic object, should be the most interesting subject brought to the notice of the student.

Some are born blind to the beauties of the world around them, some have their tastes better developed in other directions, and some have minds incapable of ever understanding the simplest natural phenomenon; but there is also a large class of students who have at least ordinary powers and ordinary tastes for scientific pursuits; to train the powers of observation and classification let them study natural history, not only from books, but from prepared specimens or directly from Nature; to give care in experiment, and convince them that Nature forgives no error, let them enter the chemical laboratory; to train them in exact and logical powers of reasoning, let them study mathematics; but to combine all this training in one, and to exhibit to their minds the most perfect and systematic method of discovering the ex-

act laws of Nature, let them study physics and astronomy, where observation, common sense, and mathematics go hand in hand. The object of education is not only to produce a man who *knows*, but one who *does;* who makes his mark in the struggle of life, and succeeds well in whatever he undertakes; who can solve the problems of Nature and of humanity as they arise, and who, when he knows he is right, can boldly convince the world of the fact. Men of action are needed as well as men of thought.

There is no doubt in my mind that this is the point in which much of our modern education fails. Why is it? I answer that the memory alone is trained, and the reason and judgment are used merely to refer matters to some authority who is considered final; and, worse than all, they are not trained to apply their knowledge constantly. To produce men of action they must be trained in action. If the languages be studied, they must be made to translate from one language to the other until they have perfect facility in the process. If mathematics be studied, they must work problems, more problems, and problems again, until they have the use of what they know. If they study the sciences, they must enter the laboratory and stand face to face with Nature; they must learn to test their knowledge constantly and thus see for themselves the sad results of vague speculation; they must learn by direct experiment that there is such a thing in the world as truth, and that their own mind is most liable to error. They must try experiment after experiment, and work problem after problem, until they become men of action and not of theory.

This, then, is the use of the laboratory in general education, to train the mind in right modes of thought by constantly bringing it in contact with absolute truth, and to give it a pleasant and profitable method of exercise which will call all its powers of reason and imagination into play. Its use in the special training of scientists needs no remark, for it is well known that it is absolutely essential. The only question is whether the education of specialists in science is worth undertaking at all, and of these I have only to consider natural philosophers or physicists. I might point to the world around me, to the steam-engine, to labor-saving machinery, to the telegraph, to all those inventions which make the present age the "Age of Electricity," and let that be my answer. Nobody could gainsay that the answer would be complete, for all are benefited by these applications of science, and he would be considered absurd who did not recognize their value. These follow in the train of physics, but they are not physics; the cultivation of physics brings them and always will bring them, for the selfishness of mankind can always be relied upon to turn all things to profit. But in the education pertaining to a university we look for other results. The special physicist trained there must be taught to cultivate his science for its own sake. He must go forth into the world with enthusiasm for it, and try to draw others into an appreciation of it, doing his part to

convince the world that the study of Nature is one of the most noble of pursuits; that there are other things worthy of the attention of mankind besides the pursuit of wealth. He must push forward and do what he can, according to his ability, to further the progress of his science.

Thus does the university, from its physical laboratory, send forth into the world the trained physicist to advance his science and to carry to other colleges and technical schools his enthusiasm and knowledge. Thus the whole country is educated in the subject, and others are taught to devote their lives to its pursuit, while some make the applications to the ordinary pursuits of life that are appreciated by all.

But, for myself, I value in a scientific mind most of all that love of truth, that care in its pursuit, and that humility of mind which make the possibility of error always present more than any other quality. This is the mind which has built up modern science to its present perfection, which has laid one stone upon the other with such care that it to-day offers to the world the most complete monument to human reason. This is the mind which is destined to govern the world in the future, and to solve problems pertaining to politics and humanity as well as to inanimate nature.

It is the only mind which appreciates the imperfections of the human reason, and is thus careful to guard against them. It is the only mind that values the truth as it should be valued, and ignores all personal feeling in its pursuit. And this is the mind the physical laboratory is built to cultivate.

MINERAL SPRINGS OF EASTERN FRANCE.

By TITUS MUNSON COAN, M. D.

THE *terræ incognitæ* are not always the most distant lands. The greater part of France, outside of Paris, is an unknown country to the greater number even of traveled Americans; and of the little-known features of that pleasant land its abundant mineral springs are among the least known. No country in Europe is so rich in mineral springs: six hundred and fifty are enumerated in a single treatise (Le Pileur's), and designated as "among the best-known springs"; while the number of different establishments, probably about two hundred, is greater than that of any other country.

Ask, now, the first neighbor you meet, this question, which I have sometimes asked, "What French mineral springs do you know by name?" Unless he is an old traveler in Europe, and sometimes even if he be an old traveler, you will not get a very long answer—"Vichy, of course; and—and—yes, Aix-les-Bains." "And any others?" you continue. The usual answer will be either "No," or "Plombières."

Of course, persons who have traveled for the sake of their health will know the springs of the Pyrenees and of Auvergne, and will have heard of those of Central France and of the Vosges. A brief description of the leading springs in this latter group may have a practical interest for some of my readers; and at least the interest of curiosity for those to whom these healing waters are but the shadow of a name.

1. Plombières.—These springs are of very ancient fame, though they have become popular only of recent years. They have been known and used since the Roman time, and in the masonry around the deepest spring you are shown mason-work which dates back to the earliest Christian centuries. In 1859 a bronze water-cock and its key, of the Roman time, were unearthed in fairly good order; on turning the key, the water rushed out in a full stream. The masonry of the sub-works is probably older than this; and it is probable that bathers were disporting themselves in these vapor-chambers, now far below the level of the ground, at least two thousand years ago.

A reminder of the ancient liberty of the latter survived, until very recently, at Plombières, in the custom of men and women bathing together; this was practiced so lately as 1881, of course under suitable restrictions as to decorum. A sufficient marble partition in the baths separated the men from the women, and strict regulations as to bathing-dresses were in force. But the bathers were numerous, and the baths were greatly crowded. In one of the bathing-rooms I was shown four marble bathing-tanks—*piscines* they call them—each a circle of about ten feet in diameter, with a dozen single bath-tubs standing near by; and in these rather narrow receptacles no less than a hundred men and women sometimes bathed at a time. Naturally, they complained of the situation. Rules and bathing-dresses are very well, but such propinquity has its inconveniences in spite of rules and bathing-dresses; and it was finally found desirable to allot separate hours for bathing to the two "sects" (in Georgia phrase) of bathers. The only other place in Eastern France where men and women bathe together is at Vittel; but at these charming baths, which we shall study a little later, the crowd is not too great, and people can discuss evolution, or the dual nature of the soul, across the marble fender which separates the tanks, with the most perfect *sang-froid*, especially in the cooler baths. The absolute leisure and unoccupation of the bath, the unconventionality of the costumes, and the interest felt in meeting strangers under such peculiar circumstances, all invite to the consolations of talk; and many a pleasant acquaintance has had its beginning in the tanks of Plombières or Vittel, which lend themselves, as the phrase is, most genially to the humaner sympathies. It is no small consolation to some invalids to compare notes respecting their progress; and it must be remembered that the majority of those who frequent the baths at Plombières are actual invalids. As to any improprieties under the old system of bathing together, I can not testify: the worst that I

heard of was that there was a good deal of water-splashing by the friskier convalescents.

But let us approach the splendid establishment which lies nearest the railroad-station, the *Bain Impérial*, or *Thermes Napoléon* of the Second Empire. The latter inscription is still traceable, though very faintly, under the briefer legend of to-day, "Thermes." Confucius demands somewhere, "How can a man be concealed?" and in France one must often ask himself the same of the names in the changing inscriptions on public buildings. They usually discover, if you scrutinize them a little closely, some trace of the previous occupancy—sometimes a pathetic trace. One may not sympathize with the doings of the Second Empire, and yet it rouses a lively feeling of unfair play to see this fine establishment, like many other public works which Napoleon III executed in France, stripped even of the name of the ruler who at least did much for the material prosperity and comfort of his country, as roads and public buildings throughout France testify. An author's name goes upon the title-page of his book; surely it is not less fair that the builder's name should remain upon his edifices.

The *Thermes Napoléon*, then, are the newest, finest, and most extensive of the six establishments of Plombières, and they are among the finest in France or in Europe. The *Bain Romain*, an old establishment, rebuilt in 1837; the *Bain des Dames*; the *Bain tempéré*, in which, as I have said, the bathers were formerly so crowded; and the *Bain des Capucins*, in an old church—these all lie farther up the beautiful narrow valley in which Plombières is built; and all are much frequented, the latter especially for the cure of sterility. In all these different springs the waters are warm, ranging from about 43° to 55° C. (110° to 131° Fahr.), and in the subterranean vapor-room, where the spring bursts from the rock, the temperature runs up to 153° Fahr.—quite as high as one can well face heat in the shape of vapor. It seems to burn when it first strikes your face, but a pleasant perspiration follows. This temperature, however, that of the hot spring itself, as it has been flowing for thousands of years past from the primitive rock, is not that which is used for treatment. In the steam-room the vapor-baths are given at 113° Fahr. Nearly every variety of bath known is administered in one or another of these thoroughly equipped establishments.

The waters of Plombières are of the mildest; they are classed by some as indifferent thermal waters, but they contain silicic acid and sulphate of soda. Taken as a drink, they are stimulating to the circulation and to the nerves; they are diuretic and aperient, and sometimes produce gastric disturbance and the so-called "thermal fever" at the outset of the treatment. There is, besides, an iron spring, which is cold, and which has a similar laxative effect, unusual among chalybeate waters. The baths of Plombières, at first stimulating, have

afterward a sedative effect. A bath of an hour and a half will slow the circulation, and depress the muscular forces; but the baths are not now prescribed of such length as formerly.

And their virtues? They are employed with success in the following classes of ailments:

(*a.*) Flatulent and acid dyspepsias, with atony of the digestive system.

(*b.*) Rheumatism and gout.

(*c.*) Female complaints, especially neuralgia and engorgement of the uterus.

(*d.*) Chronic neuralgias of various kinds. Dr. Liétard, the courteous inspector, and Drs. Leclère, Bottentuit, and Daviller, are among the most prominent consulting physicians of the place.

I should add that the environs of Plombières are very attractive. The village has about eighteen hundred inhabitants; it stands where the railroad ceases to climb the valley of the Augronne, and its two or three pretty streets hang along the sides of the valley like terraces, here and there connected by steep stairways built in the hill-side and leading from one level to another.

There are pretty excursions, as everywhere in this part of France. The *Ferme Jacquot*, the *Fontaine Stanislas*, the valley of the Semouze, the Val d'Ajol, Hérival and its ruins, Saint-Etienne, a curious town of the seventh century, and the picturesque city of Remiremont, mountain-girdled, with the ruins of the ancient abbey—these are among the places to see. For a longer excursion, one should spend two days in visiting Gérardmer and the mountain-lake, high among the Vosges. But I need not specify any more pretty places in a country which is so beautiful as the east of France.

2. Luxeuil, in the Haute-Saône.—This is a pleasant little town, about three thousand years old, near the new Alsatian boundary of France, an afternoon's drive from Plombières. In spite of thirty centuries' growth, it has not as yet touched the round number of four thousand inhabitants, though during the season, from the 15th of May to the end of September, the place is flooded with guests. Luxeuil lies in a rolling country—not a mountainous one, but at an elevation (1,325 feet above sea-level) that gives cool, sometimes chilly, summer nights. The climate, however, is not a variable one, and one sleeps soundly at night at Luxeuil.

Judged by an American standard, its temperatures are equable, and their uniformity is increased by the protection which Luxeuil finds in a range of hills upon the north, covered with ancient forests—the *haute futaie* of the French classification. There, as elsewhere in France, the forestry department takes account of each tree in the forests, and they are classified according to their ages with systematic accuracy. The ages that divide the classes are forty, sixty, one hundred and twenty, two hundred, and lastly over two hundred years; and for

each class there is a descriptive name. The French forests are the best cared for in the world, and, whenever we are ready to cultivate and preserve our own, we shall have the advantage of French experience in this important matter.

The springs are fifteen in number, bearing names that come down, in some instances, from the Roman era. The *Bains des Benedictins, des Capucins, des Dames, des Fleurs*, are among the most used, flowing as they do under the roof of a single establishment with four others, the *Bain gradué*, the *Grand Bain*, the *Bain des Cuvettes*, and the *Bain ferrugineux*.

The establishment itself is a fine, old-fashioned building, very spaciously and solidly built, more than a hundred years ago, in the gray stone of the country, and much enlarged in the year 1853. It stands in the middle of a park, shut in on either hand by rows of magnificent oak and plane trees. The establishment lies like an island in the inland sea of hills and meadows which make up this region in the department of the Haute-Saône. They are the last northward-rolling undulations of the Jura.

I will not enumerate the *douches*, the *piscines*, the shower and plunge baths, nor the score of appliances which go to make up the installation or *plant* of this fine establishment. These appliances are, indeed, much the same in all the great European watering-places, and their elaborate complexity is a thing that interests one upon the spot, rather than in the description of it. Taking all this balneological battery, then, for granted, let me come to the description of the waters themselves and of their virtues.

They are thermal, ranging from 28° to 51·5° C. (82° to 125° Fahr.). They are abundant in quantity, and in quality they are of two classes: they are either predominantly saline or predominantly iron-manganese. Chemically speaking, they are mild waters; they are none the less very effective therapeutically. Some of the mildest mineral waters, both at home and abroad, are the most valuable.

And for what classes of complaints are the springs of Luxeuil especially indicated? There is no obscurity about the answer; and it will be an encouraging one to many sufferers.

The waters of Luxeuil are especially adapted to anæmia and to the complaints that arise from it; and especially to the nervous, as distinguished from the scrofulous, forms of anæmia. Need I say more to indicate the point I am coming at? The tired housekeeper who is breaking down from work and worry, the jaded society-woman whose rounds of fatiguing pleasures have impaired her nerves and her temper—nearly all, indeed, who represent our domestic types of worry, exhaustion, and nervous debility, especially in women, or who suffer from the still graver derangements of special functions which these involve—these are the preappointed visitors to Luxeuil. For such sufferers its waters are, I will not say exactly a fountain of youth, for our

belief is not easy in such waters; but a certain fountain of strength when rightly chosen and rightly used. The *clientèle* of Luxeuil is mostly composed of women and of young girls who are suffering from one, or more than one, of the protean forms of anæmia. I speak from my own observation when I say that relief is certain in cases of this nature, and that cure is frequent.

But the caution can not be too often repeated that cure or even relief, at Luxeuil, or at any other mineral spring, can only be expected when the right patient goes to the right spring. I would not send a scrofulous patient, for instance, to Luxeuil; Salins is the place for him, and for the cure of the particular form of anæmia from which he suffers. Even among the cases of nervous anæmia, with the resulting train of special symptoms to which I have alluded, there are some that should seek more strongly tonic waters than those of Luxeuil. If the patient will have himself rightly directed, by competent medical advice, to the springs that he requires, and if then he will go to these and no other, and there take the local treatment that he requires from the local physician—as at Luxeuil, from the highly accomplished Dr. Champouillon, or from either of his resident colleagues, Drs. Gauthier, Bertrand, or Paris—he will not regret the passing of three weeks in this health-giving place. I should add that the society is mostly French; and that the guest has to choose between furnished apartments, which are very comfortable and moderate in price, and the various hotels of the place. I found the Hôtel des Thermes comfortable, clean, and rejoicing in a pretty court-yard, where the birds sang all the morning; and it is a pleasure to record, though in a language that she does not know, and in words which she will probably never see, the courtesy with which the hostess of that hotel welcomed the present writer during his sojourn, last August, in the pleasant town of Luxeuil.

3. Bussang, a little to the east of Luxeuil, is the last French station toward the new Alsatian frontier. It is a quiet place, in the heart of beautiful mountains, which tower on every side; in the green valley below the establishment the Moselle slips quietly seaward from its sources in the Col de Bussang, near at hand. The mountain itself is pierced by a long tunnel, emerging from the eastward end of which you come suddenly upon the reft provinces, and see the uniform of the German forest-guards upon the highway.

The hotel stands alone upon a beautiful hill-side, a mile away from the ancient village; it is at an elevation of 2,188 feet above sea-level, in the very heart of the mountains; and, from every window of the large, quiet, clean, new building, the views are exquisite. The hill-slope that sweeps far upward behind it is a mountain-pasture or Alp, where shepherd-boys tend the cattle throughout the cool summer nights. There is a Swiss air about the place: the scenery, if less grand than that of the French and Swiss Jura, is very beautiful; and

Bussang is the headquarters for mountain excursions in the Vosges. The Ballons d'Alsace and Servance, with their wonderful views of the Swiss Alps, are but a few miles away, and Gérardmer, with its mountain-lake, is a day's excursion. I mention these local attractions, for at every mineral spring where such charms of mountain scenery exist, they form potent influences among those that are enlisted for the patient's cure. One can not find a more quietly delightful spot than Bussang.

These waters have been known and used for centuries. They are delicious to the taste, sparkling, cold, and strongly tonic, containing the bicarbonate of iron, manganese, and some arsenic. As in the excellent artificial Hygeia waters, the strong charge of contained carbonic-acid gas acts most beneficially as a digestive stimulant. They are used only internally as yet, though a bathing establishment is now in construction, which the courteous manager of the springs, M. Zimmermann, told me would be ready for use in the summer of 1886.

The waters are used for the following therapeutic purposes:

(*a.*) They are especially helpful to the digestion. In consequence they cure the anæmia of mal-nutrition, and some forms of obstinate chronic diarrhœa. In one case of the latter category which came under my knowledge while in Bussang, a cure was wrought after years of suffering and prostration.

(*b.*) The waters of Bussang are an efficient tonic for delicate invalids, and especially for persons of the lymphatic constitution. They are exported; but they throw down a part of their iron after being kept for a time.

4. Vittel, in the Vosges.—Coming out of the mountains to the rolling country at the foot of the Vosges, and entering the valley of the Vair, we find a very interesting and completely appointed establishment, mostly of recent date, at Vittel. The springs flow in the middle of a fine park, at an elevation of 1,102 feet above sea-level. They have been known but about twenty-five years, but they attract a multitude of guests. The town has 1,343 inhabitants; the air is pure, and there is a mild mountain climate. The establishment is under the direction of the brothers Bouloumié, of whom one, the accomplished superintending physician, speaks English well. There are a casino and a theatre, as well as every device in the way of bathing and of douches; and the place is lively, cheerful, and in every way attractive—a pleasant place of sojourn.

The waters are cold, and are either predominantly iron or calcic; they belong by their constitution to a group of neighboring springs, of which Contrexéville and Martigny are the other members. They are very abundant and limpid, with but little taste; they throw down a red deposit upon the marble tanks and basins. In composition these waters are of the type of the Carlsbad waters; but they are milder in

their action. They do not purge by indigestion, as those of Contrexéville are believed to do.

Their use is in curing—

(*a.*) Gravel, when caused by uric acid.

(*b.*) Chronic ailments of the liver and hepatic colic.

(*c.*) The gout of the anæmic.

(*d.*) Vesical catarrh.

(*e.*) Enlargement of the prostate gland.

It may be added that many cases of anæmia and chlorosis find their cure at these excellent springs.

5. Contrexéville, in the Vosges.—This is another little town in the valley of the Vair, a pleasant drive from Vittel, among rolling fields of wheat. The valley is small and narrow, cutting off the breeze in summer, so that the place is hot, according to French standards, though its temperatures never approach the fervors of our own summers. Less than a thousand people are included in the census of the place; but the summer visitors count by thousands, and among them you will find now and then an American; though the great majority of the visitors here, as at all other French spas, except perhaps Vichy, are French. The park and gardens offer a lively spectacle during the season; they are planted with fine old trees, and the usual good band of music may be heard. The establishment is built upon a peninsula formed by a loop of the stream; there are parlors for reading, for conversation, for games, and a fine casino. Contrexéville has not at all an ascetic reputation, and one of the attractions claimed for the place is that you get a better dinner here than even in Paris. Situated as it is in the midst of a fertile country, rich in almost every edible product of France, there is good ground for the claim of a superior *cuisine*—one, by-the-way, that is made for the city of Bordeaux, where they claim to give the best and the best-cooked breakfasts in Europe. Certainly, the breakfast of the Bordeaux restaurants would be hard to beat in any of the various quarters of the world.

The waters of Contrexéville are cold, limpid, colorless, with a slightly ferruginous taste and smell. On standing in contact with the air they form upon their surface the filmiest film of an iris-colored pellicle that one can imagine, and the water stains the cups and glasses in which it is used. There are four springs, all belonging to the class of calcic waters. Their action is diuretic, producing a strong effect upon the kidneys; and after the fourth day there is generally a laxative effect, which continues throughout the time of treatment. The secretory functions of the skin are sometimes increased—effects which are attributed to the indigestion of the mineral water. However this may be, some of those who take the treatment are purged by seven or eight glasses of the waters, while others bear twenty or thirty easily. The waters are cold.

Their special curative values are—

(*a.*) For uric-acid gravel.

(*b.*) For vesical catarrh.

(*c.*) For enlargements of the prostate gland.

(*d.*) For gout, especially when it is hereditary, but occurs in a subject not individually predisposed by his way of life to the disease.

In all these categories of chronic disease the waters of Contrexéville, when supplemented by the kindly care of Dr. Brongniard, Dr. Thiery, or some other of the excellent physicians to be found at this station, will usually bring either cure or material relief.

6. Martigny is a quiet place in a rolling plain of the Vosges, 1,272 feet above sea-level. The train voyages through this placid upland country almost like a steamer upon the long swell of the Pacific Ocean. You get off at a little station in the midst of the wheat and scarlet poppies that are blowing together in the summer wind, and enjoy the brilliant color which gives such a charm to the French wheat-growing districts during the summer; taking the stage, you are set down in front of a fine new establishment—brand-new, indeed, and scarcely yet completed—where groups of well-dressed people are gathered in the newly planted park, waiting for the dinner-hour to strike. The dining-room, by-the-way, is hardly large enough for the company. A larger dining-hall was in process of building when I was there last summer, and also a promenade for exercise during rainy weather. An excellent reading-room is a feature of the establishment.

The waters are calcic, and are substantially the same as those of Vittel and Contrexéville, but purge less than the latter. There are two springs, both cold, besides a "saponaceous" spring, so called from the unctuous feel or *texture* of the water, and from its milky appearance; of this, however, little use is made. Dr. Bridou, the physician in charge, is a serious and competent physician, a young man, but well versed in the complex subject of mineral waters in general, and of those of Martigny-les-Bains in particular. He makes no extravagant claims for their virtues. "Gout and gravel—*c'est tout*," he said to me with decisive frankness; "but surely it is much to cure these two grave complaints." Gravel in its most frequent form, that which depends upon the uric-acid diathesis, and gravel in many of the severer cases even, are relieved or cured by these most efficient waters. Regimen is carefully attended to, as at all of the best French spas; and while I will not say that regimen is exceptionally necessary in the treatment of gout and gravel, it is a part of the treatment that can not be dispensed with safely in any disease that depends upon mal-nutrition. The mistake of many patients is that when once they are arrived at a spring they think that the waters will do all. The contrary is especially true of chronic diseases, and chronic diseases are almost the only ones that are treated at mineral springs. For in chronic diseases a cure is not wrought by a succession of powerful remedial impacts, as in acute diseases it is often wrought. In chronic

diseases the cure depends rather upon a *consensus* of gentle influences, a sequence of impressions that, however slight, are wisely chosen and directed by the physician. And of these gentle influences those which come from the proper choice of diet and the right use of exercise are among the most important.

7. Bains, still in the Vosges, is a town of three thousand people, situated at the foot of the eastward slope of the mountains, and in a valley which is watered by a tributary of the Saône. There are eleven different springs, all warm, varying from 34·3 C. to 49° C. (94° to 120° Fahr.). Their main mineral constituent is the sulphate of soda ; carbonate of soda and the chloride of sodium are also present, and both arsenic and iron have been found in very small quantities. These waters are limpid, colorless, and have no smell or taste, emerging from the *grès vosgien* which covers in shallow strata the granite substructure of the valley. They have been known and used, like many others of the French springs, since the time of the Romans, and their yield is abundant, alike for the baths, douches, steamings, inhalations, and internal uses which are prescribed at the establishments.

These establishments, two in number, include all of the principal springs. The first, the *Bain Romain,* which occupies the center of the town, is a handsome building, with galleries and colonnades, dressing-rooms, douches, and three *piscines* or bathing-tanks in the center. In the basement are huge tanks where the water is stored ; hence it is lifted by pumps to reservoirs in the top of the building, and distributed to all of its different parts. The second establishment, the *Bain des Promenades,* is almost equally well appointed. Some two thousand guests come yearly to the place between the middle of May and the middle of September, the limits of the season ; while the course of individual treatment is commonly fixed at twenty days.

These waters have a greatly stimulating effect, which is beneficial in cases of feebleness or of nervous dyscrasia ; used as baths, they are more or less stimulating according to their temperature ; after a certain time they produce a sedative effect, in this particular resembling the springs of Plombières, which are but ten miles distant. Taken inwardly, they produce at first more or less of the so-called "thermal fever," i. e., loss of appetite, a sense of weight at the stomach, and some constipation, and, like the waters of Plombières, they are very useful in dyspepsia, when this depends upon feebleness of the nervous system ; in gout and rheumatism, and neuralgia and engorgement of the uterus. The choice between the two springs is between hill and plain, between the more fashionable and the quieter place. In either the patient will find a cure if he follows the course of hygïene and of water prescribed.

8. Bourbonne, in the Haute-Marne, is the last in the group of springs which we are studying. The town lies some fifteen miles due south of Martigny, whence I made my way by private carriage ; and

through what a region of pastoral calm, of smiling prairie and waving grain! Never have I seen such repose and beauty combined with the highest cultivation; one would call this part of France a garden of Eden, but for the fact that it is grain, not fruit, which is here mainly cultivated, and an apple-orchard is the proper connotation of the garden of Eden. On the southward limit of this lovely rolling upland, not yet invaded by the railway, a long ridge of eastward-trending hills arises; at its foot are the springs, the pretty town of four thousand people, at eight hundred and ninety-two feet above sea-level, and the railroad. On the hill-side are enormous distributing tanks, into which the steaming-hot mineral waters, too hot for use, are pumped up daily to cool under the starlight until they are at a usable temperature for the baths of the following day.

These waters, again, have been known and used since the Roman time, but especially since the sixteenth century. There are six principal springs, ranging from 28° to 66° C. (82° to 151° Fahr.); the water is limpid, with a slightly saltish taste, and one of the springs, the *Source de la Reine*, disengages a gas which has an odor distinctly the converse of attar of roses. These waters contain the chlorides of sodium and of magnesium, with sulphate of soda and a little iron; and they are used in all the ways known to modern balneology, the new establishment being completely provided with every form of apparatus—*douches*, *piscines*, vapor-baths, *baignoires*, and the new treatment by spraying with the "pulverized" or minutely divided water—a treatment now beginning to come into use at some of the springs in our own country.

Rheumatism, the scrofulous diathesis, and old wounds, are the ailments mainly treated here; and so efficacious are these waters in the latter class of cases, that the French Government sends many of its wounded officers and soldiers here. Dr. Magnin, the old inspector, and his genial nephew of the same name, and Drs. Cabrol, Bougard, and Causard, are among the excellent physicians of the place. Among the hotels, no more comfortable and quiet place can be found than the Maison Beaurain. M. Beaurain, the most affable of hosts, speaks English as well as French, and has a most refined class of guests.

Bourbonne-les-Bains is a pleasant place, and its waters are valuable and effective. But in deciding upon treatment it is not enough to know that the waters are good and that the place is pleasant. The waters must be adapted to the particular case. The main secret of successful treatment by mineral waters is in their right choice, and as to this I have one word of serious advice. *Don't try to choose for yourself.* The right prescription and choice among these delicate yet potent remedies can only be made by a physician who understands them, who has seen and studied their action, and who also understands the case for which treatment is required.

GOOD TIME AND ITS ASCERTAINMENT.

By Professor ISAAC SHARPLESS.

THE natural divisions of time are the year and the day. The week is arbitrary, being probably derived from considerations first suggested by the first chapter of Genesis. The month, though originally intended to be the time from one new moon to the next, has, of necessity, departed from this idea, in order to make an even number in the year. The decade and the century are purely artificial, deduced from our system of numbering. But the day and the year, the one derived from the reappearance of light and darkness, the other measuring the round of the seasons, are universally adopted units of time, suggesting themselves alike to cultured and savage, and which we can not think will ever be superseded.

The year is the time of the revolution of the earth around the sun. Its measure is most easily obtained by the reappearance of the sun at the same altitude in the sky. Every one knows that it is higher in summer than in winter. If the circle of the earth's equator were extended right out from the center of the earth into the sky, it would cut out a circle there which is called the celestial equator. Now, the sun crosses this line in the spring northward, arriving at its greatest altitude in the middle of summer ; thence it descends, crossing the line southward in the fall, and reaching its lowest point in midwinter. The ancients, by measuring the length of the shadow cast by a vertical stick on different days of the year, arrived at surprisingly correct results as to the length of the year. In 450 B. C., Democritus asserted the year to be 365¼ days long, which is within about eleven minutes of the truth. Another ingenious device for the same purpose was that of the Egyptian astronomers, who set up a wheel parallel to the plane of the equator. When the sun was in this plane, the shadow of the sunward side of the wheel would be exactly intercepted by the other, and the interval between two such occurrences would measure the year. Owing to the fact that the sun does not cross the celestial equator in the same place each year, this year which measures the seasons is a few minutes shorter than the exact time of the earth's motion around the sun.

To measure the day troubled the ancients much more. It is, perhaps, a common idea that the shadow of a vertical rod cast by the sun is always exactly northward at twelve o'clock noon. Any one desirous of trying this can easily do so, and he will find that such a shadow would be sometimes eastward and sometimes westward of the meridian-mark at noon. Moreover, he will find that the time between two passages of the sun over his meridian is not the same, so that, if this time were taken as the day, there would be no uniformity. It was,

however, the recognized day in most countries till comparatively recent times. In France, when in 1816 the change was made to our present system, there were fears of a disturbance among working-people, lest the abolition of the sun-day should somehow increase their hours of labor. It met the approval of the watch-makers, however, whose customers had hitherto complained that their watches would not keep pace with the sun, not knowing that this would be impossible for a good watch.

The time of the rotation of the earth on its axis can not be measured directly from the sun, for the reason that the earth is moving around it. We must have some external point, fixed with reference to the earth, by which to measure it. The stars afford such points. By noticing the time between two successive passages of a star over our meridian (our meridian being, as is well known, the semicircle in the sky passing from the north to the south point of the horizon directly overhead), we would obtain the exact time of the earth's completing one spin on its axis. This time, which is about four minutes less than our ordinary day, is called in astronomical parlance a sidereal day, and, divided in the ordinary manner into hours, minutes, and seconds, is known as sidereal time. It has no direct relations to ordinary life.

Through all the time that the earth is making one turn on its axis it is advancing around the sun in the same direction. So it takes this extra four minutes to bring the same meridian under the sun again, after making a complete revolution. Hence we have our solar day. Again, since the forward motion of the earth is not uniform, as well as for another cause, which is too intricate to mention here, the solar days are not, as we have said above, of equal length. So the device is adopted of ascertaining their average through the year and calling it the mean solar day. This, subdivided into hours, minutes, and seconds, is mean time—the clock-time of ordinary life.

If, therefore, it is desired to find correct time from a sun-dial, or by any method depending on the sun, the correction from apparent to mean time must be made. At four instants during the year this correction is zero. At other times a quantity, amounting at its greatest to about sixteen minutes, must be added to or subtracted from sun-time. For several days in the early part of November the sun is on the meridian more than a quarter of an hour before twelve o'clock. Our present system is not exact sun-time, but sun-time so modified as to be adapted to the current wants of our existence. It is uniform, because it is based on the time of revolution of the earth on its axis, which has not varied, if at all, more than one sixtieth of a second in the past twenty-five hundred years. But the common day is not the exact time of the earth's revolution, nor is the common year the exact time of its motion around the sun.

The tendency of civilization seems to be to depart from these strict

astronomical units, while all the time depending upon them for their ascertainment. And the recent changes of using "standard time" are in the same direction. Of course, every place, not just north or south of another, has a different noon. To prevent the confusion resulting from so many "times," our railroads have adopted as noon the mean times of certain standard meridians. These are taken just one hour apart, so that if the new time were universally adopted, the minute and second hands of all correct clocks would be the same over the whole United States, and the hour-hands would differ by one, two, or three hours. In England they have used Greenwich time over the island for many years, and our system is connected with theirs by using for our standard meridians those which are an even number of hours from Greenwich. In Philadelphia, for instance, which is situated on a standard meridian, the time is just five hours later; so that tidings of an event, happening at noon in London, if telegraphed immediately, will reach Philadelphia a few minutes after seven o'clock in the morning.

The objections to adopting this standard time, in some places, based on the inconveniences of having noon at some other time than when the sun is on the meridian, very much resemble those made in France when the Government substituted mean noon for apparent. In practice we never know when the sun is on the meridian, and if it gets there at 12.30 instead of 12, no one is the worse off, and the methods of living are readily adaptable to it.

Time being thus dependent on the facts of astronomy, its ascertainment is a part of the work of an astronomical observatory. The instrument used for the purpose is a transit-instrument. It consists of a telescope which is mounted, not to be pointed to any part of the sky, but to swing only in the plane of the meridian. It will point horizontally, north or south, to the zenith, and to intermediate points. A star in the east or west can not be seen by it. When it crosses the meridian, if the telescope is elevated to the proper angle, it will cross the field of view. To determine exactly what part of the field the meridian crosses, a spider-thread is stretched in the tube just in front of the eye-piece, which by a very accurate adjustment must be made to coincide exactly with the meridian. Just as the star crosses this thread, or, to speak more accurately, just as the particular meridian of the place passes under the star, the time must be recorded. As there is a possibility of an error in this, several spider-lines are inserted parallel to this central one, and symmetrically placed on either side.

The telescope is connected with an axis pointing east and west, working on the tops of two pillars set far enough apart to allow the telescope to swing between them.

Let us now go through the operation of "taking a transit." The observer, by means of graduated circles, points his telescope to the

place in the heavens where he knows the star is to cross. He has his clock or chronometer by his side ticking seconds or half-seconds. A little lamp sends a ray into the tube of the telescope, so that he can see the spider-lines. With paper and pencil in hand he stations himself in front of the tube. The star enters the field of view and moves toward the first spider-line. He glances at the clock, catches the time by the second's hand, and counts the ticks. Three—four—five—six—the star has just crossed a line. Estimating the *tenths* of a second, he records the time on the paper. All this while he is noting the beats of the clock, and, when the star reaches the second-line, he is ready to record another transit, and so on through. The mean of all these times is the time of crossing the central line *by the sidereal clock.* But in the "Nautical Almanac" this time is given accurately, and a comparison of the two shows his clock error.

Instead of recording the transits by the "eye-and-ear" method above described, there is an easier way by simply tapping the key of an electric circuit at the time of transit. This makes a record on a "chronograph," which can be read at leisure.

A chronograph consists of a brass cylinder, on which is fastened a sheet of paper. This is placed with its axis horizontal, and is revolved uniformly by clock-work. A pen rests with its point against the paper, making a mark around it. By a slight longitudinal motion this mark does not come around into itself, but advances a trifle, being like the thread of a screw, running from end to end. A current from a galvanic battery is so arranged that every swing of the second's pendulum causes an electro-magnet to attract the armature to which the pen is attached, and makes a break in the mark. Hence there is a series of breaks separated by intervals of a second. When the observer notes a transit, he, by his key, makes galvanic connection and interjects another break in the line. The position of this break among the seconds tells when the transit occurred, the fractions of a second being readily read.

He thus knows sidereal time; a little reduction gives him the mean solar time of the place of observation, from which the time at any other place whose longitude is known is directly deduced.

His telescope, to avoid all possibility of error, must be in perfect adjustment. The axis must be level; it must point east and west; his spider-line must be correctly placed in the tube; the pivots of the axis must be of equal size and uniformly round, and the axis must not bend under the weight of the tube. All these sources of error are carefully guarded against, but, as human powers are finite and disturbing causes very plentiful, errors will be introduced in various directions. So he seeks to nullify these by taking many stars in different parts of the sky, and from the varying errors he deduces what part belongs to the clock and what to the instrument. Should cloudy weather continue for many successive days and nights, he has to fall back on his

knowledge of the rate of his clock, which is kept under as uniform conditions of temperature and moisture as possible. There must be something radically wrong, either with the observer or his equipment, if he can not give the time of noon within a very few tenths of a second.

RECENT PROGRESS IN CHEMISTRY.*

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TO many intelligent and cultivated persons not specifically instructed in chemistry, this word recalls confused memories of colored liquids, glistening crystals, dazzling flames, suffocating fumes, intolerable odors, startling explosions, and a chaos of mystifying experiments, the interest in which is proportional to the danger supposed to attend their exhibition. Further reminiscences are of many singular objects in wood, metal, glass, and earthenware, of flasks and funnels, of retorts and condensers, furnaces and crucibles, together with bottles innumerable filled with solids, liquids, and gases, the whole paraphernalia connected by glass tubes of eccentric curves, and displayed in inextricable confusion and meaningless array. Behind this chaos arise vague memories of one discoursing learnedly in a polysyllabic jargon, and attempting to explain the unusual phenomena by the aid of abstruse hypotheses, but utterly failing to remove the sensations of awe and of mystery bordering on the supernatural which overwhelm the hearer—impressions that have clung to chemistry ever since its entanglement with the superstitions of alchemy, astrology, and the "black art."

Persons who undertake to gain through chemical literature a knowledge of what chemists are doing in and for the world encounter a discouraging nomenclature which repels them by its apparent intricacy and its polysyllabic character. Their opinion of the terminology of an exact science is not enhanced when they learn that "black-lead" contains no lead, "copperas" contains no copper, "mosaic gold" no gold, and "German silver" no silver; that "carbolic acid" is not an acid, "oil of vitriol" is not an oil, that olive-oil is a "salt," but "rock-oil" is neither an oil nor a salt; that some sugars are alcohols, and some kinds of wax are ethers; that "cream of tartar" has nothing in common with cream, "milk of lime" with milk, "butter of antimony" with butter, "sugar of lead" with sugar, nor "liver of sulphur" with the animal organ from which it was named.

Readers of chemical writings sometimes fail to appreciate the advantages of styling borax "di-meta-borate of sodium," or of calling

* From an address read before the New York Academy of Sciences, March 15, 1886. Revised by the author.

common alcohol "methyl-carbinol," and they ignore the euphony in such words as pentamethyldiamidothiodiphenylamindiiodomethylate (a substance begotten and baptized by Dr. Albert Maasen).

Those whose chemical education consisted in attendance on a course of lectures illustrated by experiments performed in their presence, interspersed with occasional recitations from a prosaic text-book which taxed the memory in true Chinese fashion, may be pardoned for retaining very hazy impressions of the true character of the science. On the other hand, many thinking and reading persons recognize the magnitude of the scope and operations of chemistry, and have some appreciation of its benefits to mankind.

The fields of chemistry explored by zealous investigators are prodigious in extent and diversity; in its various sections, analytical, agricultural, pharmaceutical, physiological, and technological, it yields fruit of infinite value to the human race, and, co-operating with other sciences, produces results which promote civilization in the highest degree. So rapidly are new methods of cultivation applied to these fields, so numerous and active are the workmen engaged in tilling them, that the harvest is too abundant for mental storage, and those who survey the operations at a distance are quite unable to apprehend the products. This inability to follow the advances made by chemical science is felt not alone by those whose imperfect and non-technical training has illy fitted them for the task; even the specialist stands aghast at the prospect, and, abandoning attempts to apprehend the progress made in all departments, confines his reading and research to a limited number.

The twelve principal chemical societies of the world have an aggregate membership of nearly nine thousand;* almost all of these members are actively contributing to the advancement of chemical science, publishing their results for the most part in periodicals especially devoted to the subject. Excluding transactions of societies and journals

* The membership in these societies is distributed as follows:

Deutsche chemische Gesellschaft zu Berlin	2,950
Society of Chemical Industry (England)	2,400
Chemical Society of London	1,500
Société chimique de Paris	560
Institute of Chemistry of Great Britain and Ireland	430
American Chemical Society	250
Society of Public Analysts (England)	180
Chemical Society of St. Petersburg	160
Associazione chimico-farmaceutica fiorentina	*200
Chemical Society of Tokio, Japan	86
Chemical Society of Washington, D. C.	48
Association of Official Agricultural Chemists (U. S. A.)	17
Total	8,781

* Estimated. Many chemists are members of several of the above societies, but against this duplication may be set those not connected with societies.

of physics and pharmacy, these chemical periodicals issue annually about twenty thousand pages. Bearing these statistics in mind, are we not justified in feeling appalled at the idea of presenting within the compass of an evening's address a review of recent progress in chemistry? Any attempt to do more than glance at a few salient points is obviously out of the question. "Recent" time will of necessity be a somewhat variable quantity, its limits being determined by expediency. We shall also endeavor to bear in mind the fact that we address an audience not exclusively composed of professional chemists.

Much interest is commonly attached to announcements of new forms of matter—an interest out of proportion, perhaps, to the real value of the discoveries. During the last nine years chemists have not failed to sustain this interest, for they have proclaimed no less than thirty-four new elementary bodies. The ambition of these chemists, however, has been greater than their accuracy, for of these thirty-four bantlings but five or six have survived the scrutiny of the doctors, two or three are now in precarious health, and the remainder have been cremated without ceremonies. Of the youthful survivors comparatively little is known; their character is being severely tested, and their future destiny and utility are yet uncertain. The extreme rarity of the minerals in which the new elements have been detected, the excessively small percentages of the new ingredients, the extraordinary difficulties attending their separation from known substances combine to render the investigations laborious, protracted, and costly. From twenty-four hundred kilogrammes of zinc-blende, Lecoq de Boisbaudran, the discoverer of gallium, extracted sixty-two grammes of the precious metal; compared with this element, therefore, gold is both abundant and cheap. Ytterbium, scandium, samarium, thulium, and the rest, will long remain mere chemical curiosities known to but few; probably the most sanguine will not claim for them a future place among substances of economic value.

But of far greater importance than the elements themselves is the marvelous delicacy of the means used in detecting and isolating them. When Bunsen and Kirchhoff presented to scientists the instrument which combines the penetration of a telescope with the power of a microscope magnified a hundred-fold, they were enabled to disclose Nature's most hidden secrets. The new elements have been traced to their hiding-places, their differences established, and their subsequent purity demonstrated, chiefly by their emission and absorption spectra. Three years ago, William Crookes, who had already discovered thallium by the aid of the spectroscope, announced a novel and remarkable extension of the power of this instrument. Crookes found that many substances, when struck by the molecular discharge from the negative pole in a highly rarefied atmosphere, emit phosphorescent light of varied intensity. Having observed under these conditions a bright citron-colored band or line, he pursued the substance producing it, and,

after a laborious search, found that it belonged to yttrium. Subsequent studies showed this modification of spectrum analysis to exceed in delicacy all known tests for the rarer earths; yttrium can be detected when present in one millionth part. Within a twelvemonth, Crookes has made known the application of radiant matter spectroscopy to samarium; the delicacy of this test surpasses that for yttrium, and the anomalous behavior of the mixed earths yields phenomena "without precedent."

When Dalton, the Manchester schoolmaster, added to the atomic theory of the Greeks the laws of definite and of multiple proportions, he transformed an "interesting intellectual plaything" into an exact scientific theory capable of experimental demonstration. The importance of ascertaining the atomic weights of the elements with the utmost accuracy has stimulated chemists to apply to the problem their best endeavors; and as the methods of analysis become more refined, the determinations are again and again repeated, every ascertainable and imaginable source of error being carefully eliminated. Besides the experimental repetitions, the figures obtained by various observers have recently been submitted to careful recalculations by Clarke in this country, and soon after by Lothar Meyer and Seubert, in Germany. Their labors give chemists the latest and most reliable constants.

For many years chemists have dimly perceived the probable correlation of the properties of the elementary bodies and their atomic weights. Dumas pointed this out for certain marked groups, Newlands emphasized it; but it remained for a Russian chemist, Mendelejeff, to establish, in 1869, a law of great importance. Mendelejeff showed that if the elements are grouped in the order of their atomic weights, it will be found that nearly the same properties recur periodically throughout the entire series. This so-called Periodic Law is more concisely stated thus: The properties of the elements are periodic functions of their atomic weights. The accuracy of the deductions based on this law is strikingly shown by the fact that Mendelejeff, finding an unfilled blank in the periodic system, boldly announced the general and special properties of the element awaiting discovery; six years later, Lecoq de Boisbaudran discovered gallium, an element which proved to have properties almost identical with those of the hypothetical *eka-aluminium* described by Mendelejeff. And in 1879 the accuracy of Mendelejeff's prophecy was further confirmed by Nilson's discovery of scandium, the counterpart of the hypothetical *eka-bor*. *Eka-silicon*, though yet to be discovered, may almost be regarded as a known element, so fully have its properties been predicted.

The correlation between atomic weights and physical properties is being extended, and now embraces the fusibility, boiling-points, general affinities, color, occurrence in nature, physiological functions, and many other factors. Dr. Carnelley, who has been active in develop-

ing this subject, at the Aberdeen meeting of the British Association, proposed a "reasonable explanation" of the periodic law; he regards the elements as compounds of carbon and æther, analogous to the hydrocarbon radicals, and suggests that all known bodies are made up of three primary elements—carbon, hydrogen, and æther—an assumption which can not be disproved. In recent years the periodic system has exerted noteworthy influence on the classification of the elements and their compounds. It is of positive utility in determining unsettled questions concerning new and rare elements, and is destined to maintain a lasting hold on chemical philosophy.

The question whether the known elements are truly primary forms of matter has long occupied the thoughts of chemists, and the problem constantly acquires new features. The influence of high temperatures on the spectra of the metals has been a fruitful source of speculations. In 1878 the English astronomer and physicist Lockyer announced the discovery of the resolution of the elements into one primary matter; but when Lockyer's paper was read before the Royal Society his discovery proved to be little more than a hypothesis, and that not a new one, he having been virtually anticipated by Professor F. W. Clarke, of Washington. However, Lockyer's hypothesis was based in part upon experimental evidence. After eliminating coincidences in the lines of the spectra of various metals, due to impurities, so large a number of identical lines remained that he advocated the assumption that these are produced by a primary matter common to the so-called elements. He pointed out that in the hottest stars, Sirius for example, hydrogen only is present, and argued that at extremely high temperatures the so-called elements are broken up into hydrogen, the ultimate matter of the universe. Lockyer's announcement excited, temporarily, a lively interest, but his views are not regarded as supported by sufficient evidence.

More recently, the doctrine of "structure" has been borrowed from organic chemistry, and applied to the elementary bodies; the relations existing between the elements is so similar in many respects to the relations between the hydrocarbons in a homologous series that the elements have been regarded as compounds of carbon with an unknown primary form of matter. Experimental evidence is lacking, but the hypothesis takes a plausible form.

During the past year an Austrian chemist has announced the decomposition of didymium by purely chemical means, and the discovery of praseodymium and neodymium as its constituent elements. An English chemist claims to have evidence of the existence of an allotropic form of nitrogen. Both these statements await confirmation.

The views of chemists concerning the nature of affinity and chemical action are undergoing modifications destined to wield an important influence on the science in the near future. The notion has prevailed, though not distinctly formulated, that the chemical attraction exerted

between unlike atoms is a superior sort of cohesion, powerful and absolute; and this force was thought to operate between two elementary bodies directly, without the intervention of a third kind of matter. That this so-called affinity is radically affected by physical state, by heat, and by electricity, has been admitted, but the conviction is growing in the minds of chemists that many circumstances influencing the union and separation of elements have been overlooked; they are beginning to believe that chemical action does not take place between *two* substances, and that the presence of a third body is important, if not, indeed, indispensable. Many years ago the word catalytic was coined to describe certain isolated phenomena little understood. These phenomena are familiar to chemists, and the number is increasing; the word catalytic is, however, in disfavor, and the term contact-actions is now current. The well-known influence of finely divided and heated platinum in effecting the union of sulphur dioxide and oxygen and the action of metallic silver in decomposing ozone without itself undergoing any change are examples. In these and similar changes one of the substances indispensable to the reaction remains unchanged, and its *rôle* can not be expressed in equations.

There is another class of reactions in which one body acts upon another only through the aid of a third, which maintains its identity at the close of the reaction, yet is known to be decomposed and recomposed successively throughout the operation. By heating a relatively small quantity of cobaltous oxide with bleaching-powder, the latter is wholly decomposed, yielding calcium chloride, water, and oxygen, yet at the close of the reaction the cobaltous oxide is found unaltered. It has been shown that it is successively decomposed and recomposed during the operation. In their investigation on "Simultaneous Oxidation and Reduction by means of Hydrocyanic Acid," Professors Michael and Palmer consider it probable that many of the most important reactions of animal and vegetable life are due to the intercession of substances which undergo change during the reactions, and in the end return to their original form. They suggest also that some of these reactions seem to be dependent on substances capable of decomposing water into its elements, or into hydrogen and hydroxyl; and, when the chemist can command a reagent possessing that property at a low temperature, their imitation in the laboratory may follow its discovery.

That chemically pure zinc is not soluble in dilute sulphuric acid has been known since Faraday's day; that sodium does not combine with perfectly dry chlorine, even if the metal be heated to its fusing-point, was shown by Wanklyn in 1869; more recently, Mr. Cowper has found that dry chlorine does not attack Dutch metal; six years ago, Mr. H. B. Dixon demonstrated before the British Association that a well-dried mixture of carbon monoxide and oxygen can be subjected to the electric spark without exploding. In March, 1885, Mr.

H. B. Baker communicated to the London Chemical Society results of his experiments on the influence of moisture in the combustion of carbon and of phosphorus in oxygen, his conclusions being that the combustion of dry charcoal in dry oxygen is incomplete and slower than in ordinary moist oxygen. In the discussion which followed Mr. Baker's paper, Dr. Armstrong pointed out the importance of these new facts in defining more accurately conceptions of chemical action, and suggested that chemical action is "reversed electrolysis." In his address as President of the Chemical Section of the British Association for the Advancement of Science (September 10, 1885), Dr. Armstrong further discussed this subject, and stated that the idea conveyed by the expression "reversed electrolysis" is found in the writings of Faraday, neglect of whose teachings retards the progress of chemistry.

Liquefied ammonia at $-65°$ does not combine with sulphuric acid, but swims on its surface without mixing with it. Donny and Mareska long ago showed that sodium retains its luster in liquid chlorine at $-80°$, and quite recently Professor Dewar demonstrated that liquid oxygen is without action on sodium, potassium, phosphorus, solid sulphuretted hydrogen, and solid hydriodic acid. He further experimented with other substances normally active, and found their affinity at very low temperatures destroyed.

The speed of chemical reactions is an important factor in chemical theory, the study of which has but recently begun. Wenzel long ago held that the affinity of metals for a common solvent, such as nitric acid, was inversely as the time necessary to dissolve them, and he experimented with small cylinders partly protected by wax. Gladstone and Tribe have made attempts to ascertain the rate at which a metallic plate precipitates another metal from a solution, and they announced a definite law. Professor John W. Langley has since shown that, while their experimental work was correct, their method was faulty, and the results fallacious; he thinks it probable that the true law of chemical action where one metal precipitates another should be thus stated: The time during which one atom replaces another in a compound molecule is constant, and the total rate of chemical action varies directly as the mass of the reacting body in solution.

In his address before the Chemical Section of the American Association for the Advancement of Science, at Philadelphia, Professor Langley discussed the problems of chemical dynamics, and pointed out the rich store of promise in this neglected field. Physics deals with three quantities—space, mass, and time. Chemistry has too long been content with studying the changes of matter in terms of space and mass only—that is to say, in units of atomic weight and atomic volume. The discovery of a time-rate for the attractions due to affinity is destined to throw new light on chemical science, and to render it capable of mathematical treatment.

A prodigious amount of work has been done in thermo-chemistry,

and within a few years the multitude of isolated observations have been collected, classified, and made available. The importance of this undertaking will be more appreciated in the future than it has been in the immediate past. In all cases of chemical change, energy in the form of heat is either developed or absorbed, and the amount is as definite in a given reaction as are the weights of the substances concerned; hence, measurement of the quantity of heat set free or absorbed in chemical reactions often enables the chemist to determine the true nature of the change. For example, the exact condition of certain bodies in solution can only be conjectured from certain physical characters, few and ill-defined; but by thermic methods of investigation the bodies formed can be accurately ascertained. This is accomplished by reference to the law of maximum work: "In any reaction, those bodies, the formation of which gives rise to the greatest development of heat, are formed in preference to others." Thus the thermometer alone in skillful hands determines the *a priori* necessity or impossibility of a reaction.

Berthelot, in Paris, and Thomsen, in Copenhagen, have pursued the subject of thermo-chemistry with indefatigable zeal, and their published results form monuments of exhaustive research. "By the labors chiefly of these two men, we now know the thermal values corresponding to many thousands of chemical reactions. We have learned that the energies of a reaction which can be brought about in two methods, either in the dry way or by solution, differ in the two cases; that salts in solution are in a partial state of decomposition; that the attraction of a polybasic acid radical is not the same for the successive portions of base added, and that the behavior of a monobasic acid in solution differs essentially from that of a dibasic or tribasic acid. We also know that the total energy involved in any reaction is largely influenced by the surrounding conditions of temperature, pressure, and volume."

The interesting border-line between chemistry and physics is an increasing subject of research on the part of both the chemist and the physicist. The periodic press chronicles profound studies of the relations between chemical constitution and the phenomena of diffusion, of capillarity, of dialysis, of dissociation, and of the law of isomorphism. We read investigations on the value of the theory of atomicity, and on the nature of nascent action. Researches in the domain of electro-chemistry, especially in connection with the various forms of storage-batteries, and in relation to the methods and results of electrolysis, are of such importance as to merit a whole address. The press also records numerous studies in actinometry, of the relations between chemical composition and fluorescence and phosphorescence, as well as of polychroism, and of the results of spectrum observations. Noteworthy are the special applications of optical methods to the determination of molecular structure, viz., the relations between chemical composition

and (1) the refractive power; (2), the power of rotating a ray of polarized light; and (3), the absorption spectra of both inorganic and organic bodies.

The meeting of the French Academy of Sciences, held the day before Christmas, 1877, was rendered memorable by the announcement that oxygen gas had been liquefied by two independent experimenters. Previous to that date, hydrogen, oxygen, nitrogen, nitric oxide, marsh-gas, and carbon-monoxide had resisted all attempts to liquefy them, whether in the hands of the skillful Faraday, the ingenious Natterer, or the learned Andrews. Physicists and chemists, while admitting the class of so-called permanent gases, had for many years looked forward to their eventual liquefaction, yet the final success came as a surprise. This success was the result of the enterprise and ingenuity of a French iron-master, M. Cailletet, and of a Genevan manufacturer of ice-machines, Raoul Pictet, working independently. In each case, the process consisted in simultaneously exposing the gases to a very high pressure and a very low temperature. Pictet obtained the necessary pressure by generating the oxygen in a wrought-iron vessel strong enough to withstand an enormous strain, and the low temperature was secured by the rapid evaporation of liquid carbonic acid; Cailletet, whose apparatus was marked by extreme simplicity, obtained the great pressure by means of a hydraulic press, and the low temperature by suddenly diminishing the pressure upon the compressed gases. Descriptions of apparatus without diagrams are seldom intelligible; in this place they are superfluous, for we deal with results rather than with methods. Being ignorant of the "critical point" for oxygen, both experimenters employed a much greater pressure than necessary.

Since the initial successes, the problem of liquefying the quondam permanent gases has been successfully attacked by several experimenters, especially by Wroblewski and Olzewski, whose names indicate their nationality. By employing liquid ethylene (which boils *in vacuo* as low as −150° C.[−238° F.]) as a means of cooling the gases under pressure, both oxygen and nitrogen, as well as atmospheric air, have been liquefied at very moderate pressures.

Among the interesting results obtained are the following: at −102° C. (−152° F.), chlorine forms orange-colored crystals; at −115° C. (−175° F.), hydrochloric acid is a solid; at −118° C. (−180° F.), arsine forms white crystals; at −129° C. (−200° F.), ether solidifies; at −130° C. (−202° F.), absolute alcohol solidifies; at −184° C. (−299° F.), oxygen boils; at −191·2° C. (−312° F.), air boils; at −205° C. (−337° F.), air boils *in vacuo*. These extraordinary temperatures were measured by means of a hydrogen thermometer and by a thermopile. The lowest temperature measured (to date) is −225° C. (−373° F.), which was reached by reducing the pressure of solid nitrogen to 4 mm. mercury (Olzewski). Further noteworthy results are as follows: Nitrogen was obtained in "snow-like crys-

tals of remarkable size"; the liquefaction of air has been so conducted as to obtain two distinct liquids separated by a perfectly visible meniscus (Wroblewski); and, finally, when hydrogen was subjected to between 100 and 200 atmospheres pressure in small glass tubes surrounded by oxygen boiling *in vacuo*, it condensed to colorless drops.

These noteworthy results are triumphs of physics rather than of chemistry, but no review of chemical progress can afford to omit them; their bearing on the molecular theory of matter justifies the space given them. It seems probable, moreover, that every known substance on the face of the earth will be eventually obtained in solid form by the mere withdrawal of heat. At these low temperatures the chemical activity of bodies is greatly lessened or ceases, but additional observations must be made on this point before attempting generalizations.

Experiments of the character described demand great resources and are not devoid of danger; those conducting them will be rewarded by undying fame.

The progress of chemistry, in its more material aspects, is characterized by the improved and economic production of known substances, by the discovery and manufacture of entirely new ones, and by novel applications of both these classes as well as of waste materials. The necessity of utmost condensation precludes enumeration of even a centesimal part of the processes and products, nor would the mere catalogue be profitable. Omitting for the present the prolific department of organic chemistry, brief mention may be made of improvements in the metallurgy of nickel (now known to be malleable and ductile), of attempts to cheapen the production of aluminium, of the revival of the barium-dioxide process for manufacturing oxygen on a large scale, of novelties in artistic keramics, of the industrial production and application of the rare metal vanadium, of the successful introduction of water-gas as an illuminating agent, and of constant activity in the fascinating field of photography.

No chemical manufactures are more important than those grouped under the name "alkali industry," which comprises the production of those adjuncts of civilization, carbonate of soda, caustic soda, bicarbonate of soda, and bleaching-powder. Conducted by the methods originated by the ill-fated Nicolas Leblanc, they have, after a century's successful career, begun to give way to a youthful rival. The struggle to maintain the supremacy of Leblanc's process has been severe, the problem being a purely financial one. At first, the profits were made exclusively on the soda; then the decreasing profits, as well as the necessity of condensing the torrents of hydrochloric acid, led manufacturers to add to the production of alkali that of bleaching-powder, and the latter then yielded the profits, while the soda became a by-product. Sharp competition in England and France pushed prices below profitable production, and capitalists with millions in-

volved found their chemical ingenuity severely taxed. Various economical methods of recovering waste by-products were adopted, and finally attention was turned to the "burned ore" or "pyrites-cinders" obtained in roasting pyrites for the sulphuric acid; this is now treated for copper, silver, and, to some extent, for gold. A Spanish company, owning enormous deposits of pyrites on the Rio Tinto, plan to establish in France alkali-works with the intention of deriving their profits solely from the residual oxide of iron and the copper.

Forty-eight years ago alkali manufacturers might have seen a cloud arising, no bigger than a man's hand, which gradually grew darker and heavier, and now threatens to overwhelm the Leblanc process. Dyer and Hemming patented the so-called "ammonia process" for manufacturing soda in 1838; Schlössing and Rolland attempted to carry it out practically in 1855, but it was not found profitable. The credit of overcoming the practical difficulties, and placing the process on an economical basis, belongs to Solvay, of Brussels, who began to manufacture so-called "ammonia-soda" in 1866. Commencing with the modest yield of 179 tons in that year, he increased it in ten years to 11,580 tons, and in 1883 about forty per cent of all the soda made on the Continent was produced by the ammonia process. The success of the new process has completely killed the Leblanc method in Belgium, and has caused the closing of many works in England. A drawback to the new process is that no hydrochloric acid is produced, yet chloride of lime is always in demand; hence a high authority, Dr. Lunge, thinks that in the future the two processes will, of necessity, exist side by side. Mr. Rowland Hazard and others, having secured the right to work under Solvay's patents, have established a manufactory at Geddes, near Syracuse, New York. The estimated production of these works for 1886 is thirty million kilos, and the soda obtained is of great purity. It will be interesting to watch the future of this industry in America.

In modern chemical literature by far the greatest amount of space is occupied with researches and discoveries in organic chemistry. To the non-professional reader the peculiarly technical language, abounding in words of unusual length, is not only incomprehensible, but positively forbidding. A vocabulary which contains such terms as toluyldiphenyltriamidocarbinol acetate and methylorthomonohydroxybenzoate does not encourage the casual reader; and when he learns that the first-named body is the dye-stuff commonly called magenta, and that the second is the innocent oil of wintergreen, surprise gives way to feelings of despair. When one is gleefully informed that a distinguished foreigner has discovered that orthobrombenzyl bromide treated with sodium yields anthracene, which, heated with nitric acid, yields anthraquinone, and that anthraquinonedisulphonic acid fused with potassium hydroxide furnishes dioxyanthraquinone, the lay hearer can hardly be expected to become enthusiastic over the announcement,

and yet these operations conducted in the private laboratory of a man of genius have been of direct benefit to mankind, setting free thousands of acres for the production of breadstuffs, and establishing industries employing a multitude of workmen. In a word, these abstruse phrases describe the artificial production of alizarine, the valuable coloring-matter of madder.

The polysyllabic nomenclature now prevailing expresses to the chemical mind the innate structural composition of the body named; of late years the words are formed by joining syllables to an almost indefinite extent, and a distinguished chemist has recently urged the advantages of empiric names in place of the unwieldy system. Whether Dr. Odling's plea will produce a reaction in favor of empiric names remains to be seen.

To enter into details concerning the recent progress of organic chemistry, and to make them intelligible to an audience not composed of well-read professional chemists, is an undertaking of doubtful success; we shall content ourselves chiefly with generalities.

That remarkable product of nature, petroleum, continues to occupy the studies of chemists at home and abroad. Newly invented methods of fractional distillation have disclosed previously unsuspected constituents and peculiarities. Lachowitz has found in the petroleum of Galicia several members of the aromatic series; Mendelejeff has noticed abnormal relations between the specific gravity and boiling-points of successive fractions in distilling American petroleum. The various commercial products from crude petroleum, rhigolene, vaseline, paraffin, etc., continually find new and useful applications, their names being household words.

The industrial and scientific novelties in the important groups of oils and fats, alcohols, and acids, can not be specified. After cane-sugar, glucose is receiving the most attention; in the United States and Germany are sixty manufactories of the various grades of starch-sugar, the annual home production alone being valued at ten million dollars. Glucose is extensively used as a substitute for cane-sugar in the manufacture of table-syrup, in brewing, in confectionery, in making artificial honey, and in adulterating cane-sugar, as well as in many minor applications. Recent experiments by Dr. Duggan, of Baltimore, show that glucose is in no way inferior to cane-sugar in healthfulness. Much work has been done on sorghum by Dr. Peter Collier, and the first complete examination of maple-sugar has lately been made by Professor Wiley, of the Department of Agriculture. Lovers of the latter sweet will be pleased to learn that it can be made by adding to a mixture of glucose and cane-sugar a patented extract of hickory-bark which imitates the desired flavor.

The great demand for high explosives as adjuncts to engineering, mining, and military operations, occasions constant experimentation; besides the invention of mere empiric mixtures of known substances,

chiefly nitro-compounds, much work is done of a purely scientific nature, such as investigations on the chemical reactions and products of explosive mixtures, on the heat disengaged by their explosion, on the pressure of the gases produced, and on the duration of the explosive reaction. Thanks to the "Notes" of Professor C. E. Munroe, of the United States Naval Academy, chemists are informed of the freshest novelties in this department, rendering further mention superfluous.

The researches of chemists in the aromatic series outweigh in both number and importance those in all other sections. The once despised refuse coal-tar has created an entirely new chemistry, and, in its products and derivatives, is by far the most promising field for investigators. The compounds of the aromatic series have afforded some of the most notable successes in synthetical chemistry, as well as some of the most useful substances for dyeing, for hygienic and medicinal purposes. The oil obtained in the dry distillation of bones, a subject of classic investigations by Anderson, of Glasgow, forty years ago, has recently acquired new interest; one of its constituents, pyridine (C_6H_5N), has been obtained in several ways which show that it bears the same relation to certain acids derived from natural alkaloids, such as quinine, nicotine, etc., that benzene does to benzoic and phthalic acids. These facts point to the possible artificial preparation of quinine at no distant day. This view of the constitution of the alkaloids is confirmed in many ways, notably by Ladenburg's discovery that piperidine, a base occurring in pepper, is hexahydrobenzene.

Professional chemists also acknowledge the marvelous success in unraveling the complications of isomerism, and the important aid afforded the study of isomeric bodies of the aromatic group by the doctrine of *orientation*. These rather technical details can receive, however, but brief mention, though a whole series of lectures could be devoted to the fascinating topic. Leopold Gmelin, when writing his "Hand-book of Chemistry," in 1827, requested organic chemists to stop making discoveries, or else he could never finish! And during the sixty years which have elapsed the activity in organic chemistry has been unceasing; yet the extraordinary number of facts now known is not so great as those which the prophetic eye sees disclosed by recently revealed lines of investigation.

The crowning glory of chemistry is the power of producing, in the laboratory, from inorganic matter, substances identical with those existing in the vegetable and animal kingdoms. Belief in the mysterious vital force operating in living beings received a rude shock at the hands of Wöhler, sixty years ago, and successive triumphs in synthesis have dispelled it entirely, so far as non-organized bodies are concerned: "To-day we know that the same chemical laws rule animate and inanimate nature, and that any definite compound produced in the former can be prepared by synthesis as soon as its chemical constitu-

tion has been made out." Within a few years chemists have announced the synthesis of many acids, essential oils, alkaloids, glucosides, dye-stuffs, and other bodies naturally occurring in the organic world, and so rapidly do these announcements succeed one another that expectation has displaced surprise. Noteworthy are the following: Alizarine, the valuable coloring-matter of madder; vanilline, the aromatic principle of the vanilla bean; cumarine, the aromatic principle of the Tonka bean; indigo, the well-known dye-stuff; uric acid, an animal product; tyrosin, likewise a product of the animal organism; salicine, daphnetine, and umbelliferone, natural glucosides and related bodies; piperidine, a constituent of pepper; and cocaine, the new anæsthetic. Besides these, many syntheses have been accomplished of bodies isomeric and not identical with the natural products.

The alchemists labored to transmute base metals into noble ones, and were destined never to realize their ambitious designs; modern organic chemists, operating on substances compared with which even the base metals are precious, produce articles more beneficial to mankind than gold itself, and, at the same time, gain, indirectly, no small store of the coveted metal.

The application of chemistry to physiology encounters the most complex and difficult problems in the science, and at the same time aims to accomplish the most beneficent results. "The physiologist complains that probably ninety-five per cent of the solid matters of living structures are pure unknowns, and that the fundamental chemical changes which now occur during life are entirely shrouded in mystery. It is in order that this may no longer be the case that the study of carbon compounds is being so vigorously prosecuted." It may seem strange to the non-professional in this audience that, in spite of persistent and skillful attempts to solve the problem, chemists are obliged to admit ignorance of the exact composition of so common a substance as the white of egg; yet, until they acquire an accurate knowledge of the constitution of albuminous substances, the processes of animal economy can not be explained. While the physiologist, in some degree, waits on the organic chemist for further developments, the latter discovers and prepares novel bodies much faster than the physiologist ascertains their influence on the animal economy. To the joint labors of chemists and physiologists are due the blessings of anæsthetics, hypnotics, and other conquerors of suffering and disease. The anæsthetic properties of cocaine, and the circumstances of their discovery, are matters of popular knowledge. Within a twelvemonth, ethyl-urethane has been added to the list of hypnotics.

In recent years sanitary chemistry has acquired great importance, and now occupies a distinctly defined field, including all that pertains to the hygienic value of foods and beverages, their adulterations, and their fraudulent substitutes; questions of gas and water supply; of the uses and abuses of disinfectants; of household ventilation, and of

the diverse matters grouped under the term chemical engineering. Of this very practical branch of chemical science, as well as of the valuable additions to materia medica, of the improved methods introduced into analytical chemistry, and of the contributions to the chemistry of agriculture, no mention can be attempted.

The tendency of modern researches in chemistry is to magnify the atomic theory; the rapid accumulation of facts, the ever-increasing ingenious hypotheses, the most searching examinations of co-ordinate laws, all tend to strengthen the Daltonian adaptation of the philosophic Greeks. Here and there a voice is raised against the slavish worship of picturesque formulæ; but, against the molecular theory underlying the symbolic system so depicted, few earnest arguments are advanced. The whole aim of organic chemistry is directed to the discovery of the arrangement of atoms within the molecule, and the success obtained justifies the hypothesis. The edifice erected through these achievements, though young in years, is too substantial to tolerate displacement of its corner-stone. The absolute truth of the atomic theory is beyond man's power to establish; even admitting that it necessitates absurd assumptions, it is, nevertheless, indisputably the "best existing explanation of the facts of chemistry as at present known."

A noteworthy feature of existing chemical research is the recognition of the necessity of a more intimate knowledge of the connection between physical characters and chemical constitution. In the past chemists increased the number of new compounds so rapidly that they often neglected detailed examination of their physical properties, their relations to known bodies and to each other, preferring to satisfy their ambition by fresh discoveries. This race after new bodies still continues, but parallel with it are zealous investigators striving after a knowledge of the innate qualities and bearings of these same bodies; and the latter class of students is gaining prizes no less valuable than those secured by the former.

Chemists are also recognizing the necessity of a more minute study of the simpler phenomena of chemistry, and it is in this direction that they look for many laurels in the future. Priestley's day of great discoveries by the simplest means has in one sense passed; the opportunities for isolating nine new gases, or of recognizing by chemical tests half a dozen new elementary bodies, in the space of a lifetime, are gone; only by the employment of the most delicate appliances, by the closest scrutiny of phenomena and the conditions governing them, by availing themselves of all the resources of physics, by an unshrinking expenditure of time and of money, to say nothing of the necessity of trained mental powers of no low order and of skilled hands, shall chemists in succeeding generations realize their ambitious designs.

THE PREDICTION OF NATURAL PHENOMENA.*

By Dr. ARNOLD SCHAFFT.

ALTHOUGH those times have gone by which oracles and soothsayers played an important part, yet even at the present day prophets are to be found almost everywhere. We will not speak here of politicians, of those that predict peace and war, nor of speculators and the so-called reformers, with their predictions in the domain of commerce and industry. We shall confine ourselves to the discussion of natural phenomena—not alone to those that are grand and striking, but shall in preference turn to the common occurrences of everyday life.

"What weather are we to expect within the next few days?" Only put the question, and a hundred answers will be volunteered. The curing of all diseases is often predicted by quacks and patent-medicine men with a degree of assurance scarcely to be believed. "This remedy never fails," is the superfluous winding-up of many an advertisement of their nostrums, and thousands of credulous people daily fill the pockets of these charlatans.

A considerable number of those persons who do not permit themselves to be thus caught err in the opposite direction—that is to say, they regard *all* predictions with mistrust. For instance, they attach but little importance to any of the attainments of medical science; they doubt the usefulness of meteorological stations, etc. And yet even skeptics like these must acknowledge that nnmerous astronomical predictions come true with a degree of precision and accuracy that must astonish every one.

What prophecies, then, are to be believed? The predictions of science? Alas! how many supposed scientific predictions have proved to be mere delusions! The word "science" will not answer in this connection. Is there, then, no standard by which the value of predictions of natural phenomena may be gauged or measured?

A standard exists, and may be determined by an acquaintance with the elements of inductive logic, and with the most important teachings of natural science. Considering the wide-spread interest that attaches to this question, it will be worth while to study the subject a little more closely.

Almost every prediction requires some statement admitted to be universally valid, from which it may be deduced. If one desires to know how probable a prediction is, it will be well to test it by the following questions: Does the prediction rest on simple enumeration?

* Translated and condensed from Virchow and Holtzendorffer's "Sammlung gemeinverständlicher wissenschaftlicher Vorträge" ("Collection of Popular Scientific Lectures").

Is it based on the general law of causation? Does it presuppose the acceptance of any theory?

Predictions and generalizations based on Bacon's system of induction and simple enumeration are the most common and best known; they are based on the observation of Nature *without experiment.* They take the facts as they are, and merely enumerate. This method governed the whole world before the development of natural science. Even to-day it is made the basis of prediction by all who are not familiar with the method of experimental investigation. In this category must be classed the sayings of country people purporting to foretell the weather. If a farmer who places faith in such sayings be asked upon what grounds his belief is founded, he will probably answer, "For so and so many years I have watched the weather, and have always known these rules to come true." At the best, his observations will have been none too accurate; and as to any actual relation between prediction and fulfillment, of course that is out of the question.

Even nowadays many families cling to the superstition that thirteen people should not be seated together at table, because it is a sign that one of the number will die in the coming year. Should any question be asked as to the *reasons* on which such a fear might be founded, a great many incidents will undoubtedly be related, instances where thirteen dined together, and death claimed a victim from among the number before the year had passed. The many occasions where thirteen have dined together and no one of the number has died within the time prescribed (and how often does this not occur in inns and other public places, and no one gives the matter a thought!), these instances are of course completely ignored. A patient, who may have consulted several physicians without experiencing relief, finally turns to one of the many patent-medicines advertised in the papers. After a time he feels better; perhaps the improvement is but temporary, as is so often the case in troubles of long standing, but then, oftentimes urged thereto by the proprietors of the wonderful medicine, he writes a letter of thanks, and anon the papers will herald the announcement, "Sure cure to all unfortunates by the famous cure-all, ——," and then comes some pompous name. Other patients think a great deal of the so-called "sympathetic" cures. When the moon is on the wane they go to a graveyard, taking care to speak to no one on the way, or they throw barley-grains over their head backward into the water, meantime muttering some incantation. If the believers in these cures be questioned as to how they can place faith in such wondrous arts, they will refer to certain instances where such means have been successfully employed; but of course they can trace absolutely no connection whatever between the remedy and its supposed effects.

Prophecies of a similar kind, that do not, however, exactly refer to natural phenomena, can only be mentioned here. Thus, a northern light or a comet is said to be the forerunner of war. The relative position

of certain stars at the birth of a child is, by the superstitious, said to bode good or evil. If a new piece of work be commenced while the moon is on the wane, or on a Friday, the undertaking is doomed to fail. The belief in good and evil omens has survived thousands of years, and has come down to the present day; in fact, the influence which this belief has on the mind can only be shaken off by calm reasoning and self-training. Many other instances of superstition, still in vogue in our enlightened times, might readily be given.

All of these are false conclusions derived in the same manner: *post hoc, ergo propter hoc* (after it, therefore because of it). A careful comparison of different cases is not undertaken, no close scrutiny or investigation is attempted, no distinction made between essential and non-essential conditions. In each case a general assertion is based on a few separate, consecutive facts; the relation between cause and effect can not be proved in any instance. In fact, if we except the example of quack-medicines cited, in all other cases, even the most vivid imagination will fail to cast a bridge—be it ever so frail—over the chasm that separates what has preceded from the *seeming* effect. In short, many prophecies that can be found and met with every day among the people, in newspaper advertisements, etc., are replete with error, and wholly unreliable. It is, then, not surprising that one comes to regard all predictions skeptically; in fact, one is entirely justified in looking upon at least nine tenths of them with suspicion.

The true observer will not rest content with the mere word "experiment," a term so universally used. If one comes to look into matters closely, it will nearly always be found to refer to mere enumeration. Rarely has a word been more misused than this one, "experiment." Science has found a more adequate expression, and terms it "induction." Induction is the means of discovering and proving general propositions. This simple definition should be remembered.

The best-known form of induction is Bacon's method by simple enumeration. Can this method be successfully applied to formulate predictions? Many scholars consider this way of going to work entirely useless for the ascertaining of truths. "Of what use can it be," they say, "to know that a certain phenomenon has taken place a hundred times? Does that afford any guarantee that it *must* take place again? Or, even granting that it may happen once more, can not the time come when it will not occur?"

Hence, induction by simple enumeration does not seem to be adapted to the finding of general truths, such as science demands, and in consequence does not seem serviceable as a means of securing definite predictions. In fact, induction *applied without the necessary caution* is the most crude and deceptive means of arriving at general truths, and gives rise to innumerable false conclusions; and yet we owe to this inadequate method some important empirical generalizations.

In many parts of Europe the saying is common, "A western wind brings rain," and it is undeniable that there is a certain connection between rain-storms and a wind from the west. Occasionally, however, rain will put in an appearance from whatever quarter the wind may be blowing. But, as rain is experienced particularly often during westerly winds, the statement above—"a western wind brings rain"—may, with some slight reserve, be permissible.

Almost every one owns a barometer. If, in the summer-time, some little excursion is planned, the mercury in the tube is watched with anxious eye to see whether it will rise, for this is generally regarded as predicting clear and dry weather, whereas the sinking of the mercury points to rain and storm. Until quite recently the true relation between these phenomena was not known to science, and yet it could be safely assumed that there was, in some way, a connection between them. Thus, Otto von Guericke, the inventor of the air-pump, in the year 1660 correctly predicted a storm from a considerable depression that he observed in the water-column of his immense barometer, which measured nineteen Magdeburg ells in length.

If we look back for a moment on these predictions in the field of natural science, we must admit that they can not lay claim to any great degree of accuracy. In Europe, as well as elsewhere, a westerly wind is often accompanied by fair weather; and sometimes it will rain, although the mercury has risen in the barometer.

Predictions like these may hence be made, but with a certain amount of reserve. Some of them, however, are predictions of a superior order—to be discussed hereafter—as in many of them the accompanying conditions are studied, and hypotheses as to the phenomena observed are formulated and discussed in connection with others. The generalizations considered thus far may only be looked upon as probable; there are, however, instances in which the probability can be more fully depended on, although, in these too, the simple method of enumeration is employed.

A case where the probability of the prediction borders on certainty is found in chemistry in enumerating the properties of chemically pure substances. If we say, "All globules of mercury have a grayish-white color, a metallic luster, are opaque," etc., these are assertions true *without exception* as far as mercury in the perfectly pure state is concerned. If we are dealing with a substance that is chemically pure, we can predict with certainty that it is endowed with certain properties. In fact, we may state it as a natural law that, under all circumstances, substances which have been recognized as identical by the comparison of a series of properties will exhibit other series of like properties. We will call this the law of coexistence of like properties, or, to be brief, the law of coexistence.

The counterpart of this is the law of universal causation. This law, so important a one for predictions, may be thus expressed: under

exactly the same conditions, the same natural phenomena will always take place.

This law is at the present time recognized by all philosophers. There is, however, a dispute as to whether it is true *a priori*, or whether it can only be proved by experience. John Stuart Mill justly insists that the latter is the case. The correctness of this law is rendered evident through simple induction by means of mere enumeration. It was only a clear understanding of this law that brought about exact repetition of scientific experiments, and made possible positive predictions of the phenomena that would follow.

Another class of predictions and generalizations is based on the law of universal causation, or Mill's induction. It was about the middle of the seventeenth century that the fundamental principle of the law of universal causation began to take root among the natural scientists, as the impression gained ground that in nature like conditions necessitate the taking place of like phenomena. Since then, this fundamental principle has gradually come to be general property of all sciences. It has even penetrated into many classes of the people, into the workshop of the mechanic, into the hut of the glass-blower. It is, however, undoubtedly true that with many persons the idea is not clearly brought to consciousness, that thousands of mechanics, miners, etc., act in accordance with it, without being able to express in words what they seem to feel instinctively. If in their work some attempt fails, if the matter turn out differently from what they had expected, nowadays, they will hardly ascribe the failure to some evil spirit who seeks to mock them, but the eyes of the common workman oftentimes will more quickly discover the fault in his appliances and apparatus, than the "evil-eye" of the superintendent.

The essence of Mill's teaching is the empirical deduction of the conception of causes. He has practically evolved this from the law of causation. When an event takes place on a certain combination of conditions, and if this event no longer results when one of these conditions is omitted, then this condition is an *essential* one, a part of the cause. What, then, is the cause of a natural phenomenon? It is the sum of the essential conditions, in consequence upon which the phenomenon invariably follows. Now, it is evident that, if the cause of a natural phenomenon be known, and if this cause occur in any given case, then the effect can be predicted with certainty. This gives us a clearer insight into the *theatrum mundi*, so that in many instances we may know on the rising of the curtain what must come.

If a chemist announces the existence and the properties of a newly discovered substance, for instance, of a new coloring-matter, and we place faith in the accuracy of his work, then we feel convinced that this substance will always be again found whenever the same conditions are brought about, although the induction in this case may be based on only a few observations, or may rest perhaps on a single but

well-observed instance. An experienced photographer knows that his work will be successful, provided he carries out with care certain directions that have proved efficient.

If new gas-works or telephone-stations are to be set up in a town, it is desirable that one proceed in the same manner as has been done in the erecting of the best of similar establishments elsewhere. If this be done, then good gas-light, etc., may be guaranteed.

At this place should also be mentioned the repetition of laboratory experiments on a large scale. In such cases the results attained may astound the lookers-on, especially if nothing of the kind has been previously known, but the originator may calmly await developments after he has once made sure of the result on a small scale. It was but a short time ago that the reefs at Hell-Gate were blasted. This grand act was brought about ultimately by the pressure of a child's finger on an electric knob, and the event took place precisely as had been expected.

Of late the correct application of the law of causation has become of great importance in agricultural chemistry. It is a well-known fact that plants need for their nourishment not only water, warmth, and light, but also a quantity of certain salts contained in the soil. When wood or other vegetable fiber is burned, ashes remain ; these represent the salts that the plant has abstracted from the ground during its life. Bearing this in mind, the ashes of the cereals, of clover, and other plants used for feeding purposes have been examined—the ashes of the seeds as well as of the leaves and stalks.

In connection with these investigations the so-called water-cultures of some plants were undertaken. These consist in raising plants in flasks with water, adding to this, in some cases, certain salts found in the ashes of the plant, and in other cases withholding some of these salts, in order to study their respective influence. In this manner the effect of the different constituents of the ash has been traced, and in this way the means have been found, not only of securing the proper nutriment for the products of the field and the flowers of our gardens, but of raising crops of a desired quality—in fact, of causing crops to grow on soil that would previously not bear at all. An effectual guard has thus been found against exhaustion of the soil and all its consequences.

The examples cited will suffice to show that considerable importance attaches to this class of predictions and generalizations, based on the law of causation. Generally speaking, these are the most reliable predictions that can be made. To what extent these are worth believing in depends, of course, on the amount of care with which the conditions that affect them have been observed, also on the extent to which they may be varied, and on the more or less accurate knowledge possessed as to the effects which are produced by these conditions.

Other predictions and generalizations are based on theories and hy-

potheses. Unfortunately, Mill's induction and the ascertainment of cause by eliminating the non-essential conditions will no longer suffice when the natural phenomena to be examined are too complex, or when several important conditions can not be subjected to observation; this may be owing to various reasons, such as excessive distance, extreme minuteness, insufficient acquaintance with the matter, etc. One has not far to seek for instances of this kind, for a great number of natural phenomena belong wholly or in part to this division. We may here refer to the complex processes which take place in the human system, to many phases of animal and plant life, to the evolution of the crust of our globe, to the problems presented by the starry heavens.

When observation and direct investigation do not suffice for the finding out of the cause, the investigator turns for aid to theory or hypothesis. These differ only in degree, and we will consider them both as theory in a wider sense. Our main interest here centers in the predictions of a theory; these afford the standard by which the value of a theory may be determined—its merits correctly judged. The larger the number of successful predictions under varying conditions, made by means of a theory, the higher will such a theory deservedly rank in our estimation.

In chemistry, the modern theory of the science well serves to illustrate this point; in physical geography, the tides furnish a striking example. It seems remarkable that Pythias already divined a certain relation between the phenomena presented by the tides and the moon. In the middle ages, however, this view of the case was again obscured by wrong hypotheses. The basis for a clearer understanding of the periodical changes of the sea's surface was presented by Kepler in his statement that, if the earth should suddenly cease to attract the waters upon it, these would immediately strive toward the moon. Why the sea should also rise on that side of the globe not facing the moon was satisfactorily explained by Newton. When the dependence of the tides on the combined force of attraction of all the celestial bodies concerned had been established, much still remained to be done in the last century in the way of accounting for and settling fine points and details. In 1740 the Paris Academy presented as subject for a prize essay the problem of a mathematical theory of the tide phenomena; in consequence, such a theory was partly developed by several competitors. But it remained for Laplace to bring mathematical calculation into harmony with the theory, by applying it to the prediction of the actual movements of the waters. Nowadays many calendars, especially those of seaports, state the exact time of the setting in of ebb and flood tide, calculated a year in advance.

The most striking proofs of the coming true of predictions based on theoretical speculation are undoubtedly furnished by astronomy. The views of Ptolemy already permitted a limited series of predictions, but the faults of his system became more and more apparent in

the course of time. A remedy for this was sought in complicated extensions of his teachings; this, however, only made matters so much worse, without explaining the facts. King Alfonso X of Castile is reported to have said to his astronomers that, if the arrangement of the universe had fallen to his lot, he would have made things much more simple. All of these difficulties were suddenly removed by Copernicus. The course of the planets now no longer appeared a cause for great perplexity, but admitted of a simple explanation and resolved itself into one grand harmony. Then, after Kepler had discovered the three laws that bear his name and which mark a new era in the science, the mathematical part of the work was brought to an end by Newton's discovery of the law of gravitation.

Eclipses of the sun and moon always attract general attention. On such occasions it is not only the phenomena themselves that call for our admiration, but mainly the art which makes possible the prediction of these events to the hour, the minute, ay, the second; by means of which one may know in advance whether the eclipse will be total, partial, or annular, what part of the sun or the moon will be first covered, how long the phenomenon will last, and from what parts of the world the eclipse will be visible.

If a prediction rest on a hypothesis prepared *ad hoc*, no matter how ingenious it may be, our doubts and our mistrust are justified. In such a case we have the right to ask for confirmation, and to demand that the hypothesis shall be extended into a theory by its sequence, and that this sequence shall stand in accordance with the actual facts. If, however, a prediction is based on a theory which approaches in thoroughness and in extensive confirmation the cases we have cited as examples, and furthermore, if the separate instance be deduced in a strictly logical manner, then the prediction is worthy of our confidence. As most systematic classifications are of value only in affording a general view of the ground, without being able to embrace all cases, so, too, in our classification, we meet with instances of transition and combination.

Of this, examples are to be found in all the sciences, but notably so in medicine, geology, and meteorology. The predictions in medicine to a great extent form transitions between the first and the second class; that is to say, they are based in part on Bacon's, in part on Mill's system of induction. Thus, of late, the theory of bacteria has come to be of great importance. This theory is of recent origin, but has deservedly many champions, and offers an insight into new ways, which medicine, in combination with natural science, must explore in order to obtain valuable results. Based on these views, which would designate certain bacteria as carriers of certain diseases, new precautionary measures have been adopted, which are to serve as a guard against the phantoms of disease; and in many places these measures have already proved of great value.

The meteorology of to-day is in a state of development similar to that of medicine. Within the recent past, this science too has made wonderful progress, and is rich in promise for the near future. The meteorological predictions prove of great service to the agricultural interests in the United States. The whole system is excellently organized and very extensive; the official publications embrace the "probabilities" and the so-called "weather-maps."

While meteorology is concerned with the rapid changes that take place in the atmosphere, the science of geology is devoted chiefly to the study of the slow changes ever going on in the crust of our globe. If the geological formation of a district be but known in its essential features, a geologist is often able to predict the finding of coal-beds, ore-deposits, etc., basing his prognostication on the occurrence of certain fossils, the order in which the strata are placed, analogous formations in other districts, and so on.

Finally, we must just refer to one class of—shall we say predictions?—that are based on illusions. To cite but one example of this type, Nostradamus predicted that in this year, 1886, the world would come to an end, because Good Friday this year happens on St. George's day, and Easter coincides with St. Mark's day—i. e., the 25th of April, the very latest date on which Easter can happen. At the present time a prophecy of this kind is only commented on as a matter of curiosity, whereas the year 1000, for which the coming-to-an-end of the world had also been predicted, witnessed a general preparation for the event.

SKETCH OF OSWALD HEER.

"IN September last," wrote the Marquis Gaston de Saporta, in July, 1884, "Switzerland, and we might say Europe—so universal was the man's fame—lost in Oswald Heer one of the most fertile of naturalists, one of the most devoted to work, the one to whom the still new science of fossil plants is indebted for its greatest progress. Not only in his own country, but far beyond, as far as explorers have been able to penetrate, from Portugal to the depth of Siberia, from Sumatra to Spitzbergen, from Nebraska to Devonshire, in Saxony, in Austria, in Russia, everywhere, in short, where fossil plants have been discovered during the last thirty years, the name of Oswald Heer has been invariably united with the publication of the plants, the determination of their age, and with the definition of all the circumstances that can aid in identifying them and in attaching a meaning to the several wholes of which they originally constituted a part. Paleontology, geography, the laws that preside over the present distribution of plants and their migrations in times anterior to ours, and the delicate considerations which appertain to the filiation of species, to the order of succession of

floras through the past, the variations of climate, the movements of the crust of the earth, all these subjects, recently hidden, now just brought to light, alike depend on the persevering labors of Oswald Heer, and derive from his researches at least partial elements for their solution." "Nature" remarked, in noticing his death, that "however the study of fossil plants may rank in the time to come, Heer's name will forever be bound up with it as its great pioneer." And Dr. Asa Gray said, on a similar occasion, that his works "make an era in vegetable paleontology. Their crowning general interest is, that they bring the vegetation of the past into direct connection with the present."

Oswald Heer was born at Niederutzwyl, in the Canton of St. Gall, Switzerland, August 1, 1809, and died in Lausanne, September 27, 1883. His father was a clergyman, originally of the Canton Glarus, and came of a family that enjoyed an honorable distinction in Swiss history. Of the three branches of the family tracing their descent from a common ancestor, Councilor Abraham Heer, born in 1580, one was extinguished in the male line in the fifth generation; the second, after having produced a number of honored statesmen, came to a similar end with the death of Federal Councilor and President of the Federation, Dr. Joachim Heer. The third branch, whose sons through five generations have nearly all been clergymen, is the one to which the subject of this sketch belonged, and it still lives in several families.

Oswald Heer was an infant of good physical promise; but before he was a year old he was brought nearly to the grave by scarlet fever, and never recovered from the effects of the attack. He was made weak for the rest of his life, for many years an invalid; but, having inherited a strong constitution, he was nevertheless capable of enduring extraordinary fatigue with great ease. In 1811 Pastor Heer was called to be director of a newly founded high-school for boys at Glarus, where he was guaranteed a position for three years, and eventually remained five years. Thence, in January, 1817, he removed to Matt, in the Kleinthal, where Oswald spent his boyhood. In that deep recess of the mountains, whose only communication with the world at the time was by an arduous bridle-path, the good pastor performed the part of a general dispenser of beneficences. He urged the construction of better roads; there being no doctor at the place, he learned to take care of those who were brought to him with frozen limbs or hurt by avalanches; he introduced inoculation for the small-pox; he taught the workmen in the slate-quarries lessons of temperance and thrift, to save their earnings rather than spend them in the beer-shops where they were paid to them; and he labored hard and with success to supply his people with improved schools.

The tendencies of young Heer's mind began to assert themselves in the earlier stages of his education, which was conducted under the supervision of his father. He kept an exercise-book, in which he reproduced a number of moral and religious stories. Among these sto-

ries was one of the education of the family of a Herr Gutman, a work apparently of a kind with our English "Sandford and Merton," with which the youth was so charmed that, not doubting its reality, he made earnest efforts to become acquainted with the children, sending letters to his friends in other places in hopes that they might be able to forward them to the proper addresses. Pastor Wyss's "Swiss Family Robinson" fell into his hands and awakened in him an intense interest in natural history. He tried, as nearly as circumstances would allow, to repeat the adventures and exploits of the four sprightly youths of this story. He had no buffaloes, and jackals, and ostriches to subdue and train; but he could catch and tame magpies, and hawks, and marmots, and foxes. His experiments were not always fortunate, but he learned. A letter which he wrote to his cousin is interesting as showing how much he admired his "Robinson," and as marking the progress he was making in the study of the ancient languages, by the comical mixture of German and Latin words in which it is composed. Four years later, in 1823, he was beginning fractions, had finished the Latin Grammar, and was interlarding his letters with French phrases. A few months later these gave way to attempts at the Greek characters, and he was learning to draw; for on the 1st of December he wrote, "To-day I finished my head." It is remarked of this period by his brother, Pastor Justus Heer, that he who afterward exhibited such great powers of memory learned his classical vocabularies and inflections only with the greatest labor, and, being chided by his father for his dullness, got up at four o'clock in the morning to give himself more time for the drill. He afterward added Hebrew to his linguistic acquirements, and gave himself object-lessons in mathematics by calculating the areas of familiar objects, taking the levels of the new road, and measuring the heights of the neighboring mountains. "Once upon a time" one of the papers containing some of his calculations was carried away by a gust of wind, and was supposed to be lost; but it was returned a few days afterward by a mountaineer, who said, "Here is a letter that came down from the sky, and must belong to the parsonage."

The enthusiasm awakened in him by the example of the Robinson boys was permanent, and was manifested in the interest he took in everything living. He attended to the milking of the goats, took upon himself the care of the bees and their swarms, and had collections of beetles and butterflies as early as 1822 or 1823. He was anxious to identify and classify his specimens, but on this subject his father could give him but little information and no scientific aid. He became acquainted with choir-director J. J. Blumer, of Glarus, who was the owner of a small collection in natural history and a few scientific books, and borrowed from him, October 4, 1823, Wilhelmi's "Description of Insects." The question now was how to make this treasure his own. His father advised him to copy out the most important parts

of the book; and he wrote out, in five thick manuscript parts, the *Coleoptera*, *Hemiptera*, and *Lepidoptera*, illustrating them with drawings in the margins of copies of the figures in the book. In thankful recognition of the aid which this work gave him, and of the kindness of its owner, he some years afterward named the oldest fossil bird of Switzerland, which he found in the slates of Matt, after the musician, *Protornis Blumeri*. Now he could pursue his collecting with a good heart, and, with the co-operation of his brothers Samuel and Heinrich, he did so; and for many years no beetle, or butterfly, or caterpillar, was safe from their hands.

His attention was at first given wholly to animals, and chiefly to insects; and it was not till June, 1827, that any evidence appears in his diaries of his beginning to take an interest in plants; but from this time on botanical references are frequent. More than a year before this, in January, 1826, he had begun the record of meteorological observations, which he kept up three times a day for two and a half years till the middle of 1828, when he went to the University of Halle. Young Heer was accustomed to make frequent excursions to the mountains, accompanied usually by his father or his brothers. In this way he became acquainted with the entomology and botany of the whole canton, and enlarged his collections and made them objects of attraction. An acquaintance with Georg Spielberg, a botanist, who was conducting a high-school at Mollis, brought him an introduction to the learned Dr. Hegetschweiler, one of the most distinguished men of the confederation in that science; and through these connections, and by means of visits which he made with his father to the leading towns of Switzerland, he brought himself into relations with nearly all the scientific men of the country. Now he offered for sale a herbarium of two hundred and fifty Swiss Alpine plants, duly labeled, with which he hoped to obtain pocket-money for his journey to the university. As the time drew near for him to go there, he became more diligent in study. He assigned a task to every hour of the day, from four o'clock in the morning till seven o'clock in the evening. The most of the time was given to theology and church history. Two hours were allotted to botany, and one hour in the evening to the care of the goats and sheep.

He started for Halle on the 30th of September, 1828, carrying his plant-box filled with bulbs. His purpose was to study theology; but, while he gave due attention to the lectures on philosophy and metaphysics and the canon of Scripture, he formed personal relations with the botanists and entomologists and the specialist in ferns, and the zoölogists whose names may be found in the lists of the faculties of Halle of that time; and, while he still nursed his religious inclinations, he also kept up and cultivated and made to grow the taste for scientific investigation. His vacations gave him opportunities to make excursions of considerable length, which he improved to the increase of

his scientific knowledge. One was upon the invitation of the naturalist Meyer, to Hamburg and Heligoland, where he saw the ocean for the first time; another was to the Harz Mountains. Toward the end of his career at the university, he accepted a call to teach pedagogy and botany at the school of the orphan-house. Fritsche, who was one of his pupils, says of his lectures, "We were of course struck with his foreign dialect, but we also took good notice that he understood his subject." His last excursion from the university was made to Berlin, where he met Ehrenberg the microscopist, Von Chamisso the circumnavigator, and Schlechtendal the famous botanist, who already knew him well by name from Hegetschweiler's mention of him in his "Schweitzer Pflanzen."

Heer left the university in March, 1831, stood his examination in theology at St. Gall in April, preached his first sermon at Wolfhalden, and was ordained on the 10th of June. His father desired him to devote his life to teaching, and to become the head of a high-school which they would found. Heer himself preferred to take a parish, where his work might give him opportunities for continued scientific investigations. Before a decision was reached, his physical condition demanding recreation, he made some important excursions among the mountains, which were quite adventurous for that time. In January, 1832, he accepted an invitation from Herr Heinrich Escher-Zollikofer, of Zürich, to go and arrange his extensive entomological collection. This was the event that decided the course of his life. He became a member of the Physical Society of Zürich, and read before it his first paper, "On the Red Snow of the High Alps." He formed a connection with Julius Froebel, who afterward lectured and conducted German newspapers in the United States, and published with him in 1834 the first number of a geographical magazine—"Mitteilungen aus dem Gebiete der theoretischen Erdkunde"—of which four numbers, in all, were issued.

Heer had not been many months at Zürich when an invitation came to him to take the pastorate of the parish of Schwande. He was already expressing regret in his letters that his attention was being diverted from theology, and he seems to have suffered a painful hesitation between the possible duty of accepting this call and continuing in his scientific work. He submitted the question to Herr Escher, who replied that the field and influence of the scientific investigator, who had the whole world, was much broader than those of the pastor, which were confined to his parish or his canton. Moreover, the naturalist too can work for God's kingdom. There were many pious pastors, but pious naturalists were, according to his present knowledge, a tolerably rare plant, and therefore the more to be prized and the more necessary to the tribe of the learned. With these conflicting views troubling his mind, he was entertaining plans for a scientific journey to India and the Himalaya Mountains, when, in February, 1834, he

was appointed a teacher of physics, botany, and mineralogy, in the High-School of Zürich. In October, 1835, he was appointed Professor Extraordinary of Botany and Entomology, in the same school, and his position and career were fixed for life. He became Professor of Botany in the university when it was founded, in 1852, and in the Polytechnicum in 1855. He founded the Botanic Garden of Zürich, and became its director, and became President of the Society of Agriculture and Horticulture in 1845. For twenty years he was a Rathsherr, or member of the Grand Council of the city. He was elected to the American Academy of Sciences in 1877.

The general character and value of Professor Heer's scientific work are expressed in the commendations passed upon it by the Marquis de Saporta and others, extracts from which are given at the beginning of the present sketch. His scientific publications, according to the list given in the "Botanisches Centralblatt" in 1884, are seventy-seven in number, besides the seven quarto volumes of the "Flora Fossilis Arctica," which comprise a considerable number of independent memoirs. They are in the departments of entomology, botany, and palæo-botany. Following shortly after his first published paper, already mentioned as communicated to the Physical Society of Zürich, were two memoirs published in his geographical magazine, on the geographical distribution of insects and plants in the Swiss Alps, the former paper of which was afterward expanded into a memoir on the Swiss Coleoptera. From this time on his labors were continuous; as M. de Saporta remarks, they touch and are interlinked, and nothing interrupts them. Beginning with the study of insects, as we have seen, he was led naturally to regard flowers, the habitual haunts of insects, and thence to the examination of the fossil insects and plants of Œningen, whence his labors expanded to embrace the fossil flora of the world. His attention was first directed to the tertiary beds of Œningen, by his friend Escher von der Linth. These beds are situated not far from Zürich, on the right bank of the Rhine, near where it issues from the Lake of Constance, and include in a series of thin sheets, like leaves of paper, innumerable impressions of insects and plants. Scheuchzer had found there, nearly a hundred years before, a skeleton which he took to be of one of the victims of the flood, but which Cuvier determined to be a salamander, and later naturalists to be a congener of species now existing in the fresh waters of Japan and in the American lakes. More than six hundred species of plants and a thousand insects have been found in these beds and described by Heer, the chief results of whose labors upon them were published between 1847 and 1853. He devoted three large works to accounts of the ancient flora and the geological past of Switzerland. The first was the "Flora Tertiaria Helvetiæ," which appeared 1855–1859, in three volumes, with one hundred and fifty-six plates; next was the "Urwelt der Schweitz," in 1865, which was translated into six lan-

guages; and the third was the "Flora Fossilis Helvetiæ" in one volume, with seventy plates. He passed the winter of 1854–'55 in Madeira, on account of his health, and on his return from there published a paper on the fossil plants of that island, and another on the probable origin of the existing flora and fauna of the Azores, Madeira, and the Canaries. In this paper, and in a work published in 1860 on tertiary climates in their relation to vegetation, as well as in parts of his larger works on Switzerland, he propounded his theory of the existence of the Continent of Atlantis, during the Miocene period; a theory to which he held steadfastly for many years, but which the later soundings have shown to be extremely improbable in fact, and his own researches to be not needed to account for the phenomena of the distribution of plants and animals over the earth.

In 1862 Heer examined the fossil flora of the lignites of Bovey-Tracy in Devonshire, and published a memoir upon them in the "Philosophical Transactions." At about the same time, he published a paper in the "Journal of the Geological Society" on certain fossil plants of the Isle of Wight. As his fame grew, fossils were sent to him in masses to be examined from all parts of the world; and we find among his papers notes on the cretaceous *phyllites* of Nebraska, the floras of Moletein in Moravia, Ruedlinburg in Germany, the Baltic miocene of Prussia, of the lignites of Zsélythales in Hungary, of Andö in Norway, and "Contributions to the Fossil Flora of Portugal." All of these works, important as they were in themselves, were only leading up to the great work of his life—the investigation of the Arctic fossil flora and the deduction from it of a satisfactory theory of the distribution of life over the earth. According to Dr. Gray, his first essay in this domain—which he has made so peculiarly his own—was in a paper on certain fossil plants of Vancouver Island and British Columbia, published in 1865; and in 1868 he brought out the first of the series of memoirs upon the ancient floras of Arctic America, Greenland, Spitzbergen, Nova Zembla, Arctic and Subarctic Asia, etc., which together make up the seven quarto volumes of the "Flora Fossilis Arctica," the last of which was finished only a few months before his death. According to M. de Saporta, he had been struck with the importance of the American element in what he called the Molassic flora of Switzerland. There was no question in it of vague analogies, but a number of dominant and characteristic species were represented by "homologues" or directly corresponding kinds now peculiar to North America, while there was nothing like them in Europe or the whole Eastern Continent, except as fossils. Among these plants were the sequoia of California, the cypress of Louisiana, the parasol palm of the Antilles, the tulip-tree, maples, and poplars, the European fossil forms of which were as like them as if they had been shaped upon living American trees as models. He saw in these resemblances, which implied that identical species were at some time in

past ages diffused simultaneously through both continents, indications of ancient territorial connections. The substitution of the hypothesis of a common origin of life at the poles and its diffusion by migrations to the southward over all the continents, for the theory of Atlantis, which he had expounded in his earlier works, was of gradual growth, and was the direct result of his examinations of the Arctic fossil flora. In this he was struck by the abundance of the species of a southern and even tropical character, which he found in beds reaching far up toward the extreme north. On the evidence of such fossils was built the theory of a warm, moist climate prevailing in the Arctic as well as in the temperate and sub-tropical regions during the Tertiary period, which, suggested by Heer, has been and elaborated by De Saporta, and is avowed by Dr. Gray.

Heer never accepted the Darwinian theory of the origin of species by variation and natural selection. To it he objected, in general, that no new species had arisen within human knowledge; that no transitional forms had been discovered anywhere; and that it was inconsistent with the progress from simpler to more highly organized beings which he conceived to be the rule of development. To account for the changes that had evidently taken place during geological history, he supposed that, at certain undetermined epochs, species underwent changes, the completion of which occupied only a relatively short time, to be again consolidated and continue unchangeable till the moment when another crisis should bring on a new recasting.

The delicate health which marked his life during the period in which he was best known to science prevented Heer's making extensive explorations in person. Most of his time was spent in his study, examining the collections submitted to him by stronger and more active men, and more capable of enduring the fatigues of such works. But it is to him, M. de Saporta remarks, that we are indebted for our knowledge of the meaning of what such men discovered. Without him, active to his last hour, it would have taken a very long time for phytologists, in the absence of any concert of understanding, to accomplish the summarizing of their aggregate work which he did so successfully, and with so much clearness and intelligence. He was a sufferer from pulmonary disease, and during the last twelve years of his life did much of his work in bed, having his papers and specimens arranged upon a table before him, while his daughter acted as his scribe. Having finished the last volume of his "Fossil Arctic Flora" in the summer of 1883, he was taken to a sheltered retreat on Lake Geneva, for the recovery of his exhausted strength; and he died at his brother's house. It is said of him by his biographer in "Science," and repeated by Dr. Gray, that "a man more lovable, more sympathetic, and a life more laborious and pure, one could scarcely imagine."

EDITOR'S TABLE.

THE CHURCH AND STATE EDUCATION.

THERE are some good things that seem just a little too good for many of those who profess to prize them most highly. One of these, we regret to say, is religious liberty. If there is any one thing that the people of this country, taken in the mass, are bent on preserving and enjoying, it is this; and yet it is this very thing that some excellent people, who are far from regarding themselves as abettors of spiritual tyranny, are continually seeking to undermine. Our excellent contemporary, the "Journal of Education," of Boston and Chicago, has lately called attention to the action of the Presbyterian Synod of the State of New York, in referring to a committee, to be reported on at the next annual meeting, a resolution affirming that, while a union of church and state in this country is not to be thought of, it would still be desirable to incorporate into "the course of State and national education" certain very specific theological doctrines, in which, as it was stated, all Christian sects agreed. These were: the existence of a personal God, the responsibility of man to God, the immortality of the soul, and a future state of rewards and punishments. We can not suppose for one moment that those who favored this resolution would wish such doctrines as these to become topics of discussion in the public schools, or to be treated as in any way open to doubt or as subject to possible future rectification. If taught at all, they would have to be taught on authority, just as the catechism might be taught in church schools. This being the case, we can not understand how the members of the synod who favored the resolution could help seeing how vain was their disclaimer of any desire to establish a connection between church and state. The whole essence of an ecclesiastical establishment consists in the assumption by the State of the right to guide individual citizens in the formation of theological opinions. It matters not how many or how few those opinions may be, how much or how little of theological subtilty their formulation may involve; whenever and wherever the State looks upon the individual as unfit to guide himself in such matters, and therefore undertakes to teach him dogmatically what he ought to believe, then and there we have the elements of ecclesiastical government.

Now, the instinct of the American people has hitherto been that theology and religion do better without the patronage of the State than with it, and that it is not safe to intrust the civil power, whether Federal or local, with the making of any law looking either to the establishment of a church or to the encouragement of any special form of religious belief. We choose our own rulers and we set them over us, not in spiritual matters, but in temporal only, and, if we are wise, we shall restrict their action even in the temporal sphere as much as possible. This by the way: What is perfectly clear is that our people do not want to receive direction in theological questions at the hands of the State, and therefore are not prepared to have theology—even its most widely accepted propositions—introduced into public-school teaching. It is felt that the State has no business to *make* opinion in these matters, which it undoubtedly would do if it were allowed to impart any theological instruction whatever. Let, for example, the propositions above mentioned become a part of public-school teaching throughout the length and breadth of the land, and the modification of opinion to which

this would lead would tend to prepare the way for the introduction of more specific theological teaching, and, little by little, we should have, by the help of the State, a kind of official theology formed, the influence of which on the development of thought, and perhaps also of morals, would be far from favorable. No better way of stereotyping a civilization could be devised than for a government, through the public schools, to undertake to tell people what they should believe on the most fundamental questions of theology and philosophy.

We should therefore strongly advise all well-meaning people to pause before they give their support to measures which certainly would not have the beneficial results which we may be sure they have at heart. In what we have said above we have assumed the success of the supposed attempt of the State to control the theological opinions of the people. But there is a possibility that things might take a different turn, and that State patronage of certain forms of opinion might tend to produce skepticism in regard to the very doctrines it was sought to protect and strengthen. We hold very strongly, for our own part, that in the public schools, controlled as they are by the civil authorities, nothing should be taught beyond the broad and demonstrable results of human inquiry. We may perhaps trust our politicians, through their nominees, to give our children *facts;* because, if they depart from facts when they are purporting to give them, it is comparatively easy to bring them to book. It is a different thing, however, to intrust them with the enunciation of theories, particularly in the region of theology. If they go wrong there, who is to check them? What standard is to be applied? If they teach in a dull, formal, mechanical way what, if taught at all, should be taught with earnestness and conviction, how are we to repair the mischief they will certainly do?

There is, lastly, a point to consider, which our contemporary, above referred to, urges with a great deal of force—the question of simple justice. It is known that, whether or not all Christian sects are agreed in accepting the theological propositions set forth, the whole community does not accept them. It may be unfortunate that it should be so—we do not discuss that question—the fact is that it *is* so; and people who want a merely secular education for their children would have reason to complain if a teaching they did not think best for their children's minds should be forced upon them. The State, be it remembered, has completely dwarfed and starved out private enterprise in education, so that the average parent has no choice but to send his children to the public school. Should, then, anything be taught there which presupposes a uniformity of opinion that does not exist? If the reason why we have no state church in this land is that we could not have one without doing injustice to some element or elements of the population, the same objection precisely will apply to having an authoritative teaching in the schools of matters that every man claims the right to judge of for himself, and in regard to which important differences of opinion prevail. The case is very simple and clear—too clear to admit of much mystification in the popular mind; and it is to the good sense of the people at large that we trust for the decisive overthrow of any measures looking to the perversion of our school system by making it an agency for the propagation of an official theology.

We invite attention to the opening article in the present number of the "Monthly," which is on a subject of great economical importance. The author, Mr. P. H. Dudley, is an engineer who has given much time and attention to special investigations of the decay of wood and its causes, and presents some

interesting and valuable facts respecting it. As will be noticed by the careful reader, he speaks of what he has himself observed, and much of what he says will be new to all but experts, as it has only recently been recognized by science. His observations establish the fact that most of the decay of wood, including what was formerly called *eremacausis* or slow combustion and dry rot—the name now representing the result, whereas it was formerly held to describe the cause—is produced by the growth of mycelia of fungi, which effect the disorganization of the wood-cells. The figure on page 438, which is from a photograph, tells more on this subject than many pages of letter-press could do. Some of the fungi described and figured by Mr. Dudley are old acquaintances to frequenters of the woods who have observed the curious forms of their *pilei* on stumps and logs, and have supposed them to be fruits of rottenness. Mr. Dudley exhibits the more essential parts of these fungi, the mycelia penetrating and interpenetrating every part of the interior of the wood, and generating the rottenness of which the *pilei* are the sign. Some suggestive observations may also be found in the article concerning the relations of moisture to the growth of fungi. Mr. Dudley will continue the subject in another article, with some practical suggestions founded on the results of his investigations.

We print in this number of the "Monthly" the last of the series of papers by Mr. David A. Wells upon the economic condition of Mexico. Accurate information of a country with which we must inevitably come into intimate political and financial relations is in the highest degree desirable, but has heretofore been very difficult to obtain. Mr. Wells—whose competency to perform the task he has undertaken will be questioned by no one—has done a valuable service, making us acquainted with the actual condition of this but little-known country. As he says, the pictures usually drawn of the natural resources of the country and its future possibilities have been rose-colored in the extreme. He finds, on the contrary, that the country is almost hopelessly poverty-stricken—to such an extent, indeed, that the problem of a stable government is beset with the greatest difficulties. With an army consuming a third of the revenue of the state, a system of internal tariffs between each of the States, or political divisions composing the republic, and with an almost entire absence, until very recently, of means of communication between different parts of the country, anything like industrial progress or political stability has been out of the question. His study of the country does not lead him to any very hopeful prediction of its future. Its natural conformation—that of a great table-land, devoid of navigable streams, with a strip of coast-land on either side which can only be reached by abrupt descents—is unfavorable to the material development of the country; while the character of the people, their extreme poverty, and the enormous load of public debt, are almost insurmountable obstacles to any great degree of prosperity. In our own interest, as well as that of Mexico, he bespeaks a kindly and helpful attitude on the part of this country toward the weaker republic, and his words are well worthy the attention of all Americans who desire to see their country without reproach in all its international relations.

LITERARY NOTICES.

Teacher's Hand-Book of Psychology. By James Sully, M. A. New York: D. Appleton & Co. 1886. Pp. 414. Price, $1.50.

In the present work Mr. Sully has attempted to reduce and simplify the statement of scientific principles contained in his former and larger work, "The Outlines of Psychology," and to expand their prac-

tical applications to the art of education, with the view of "satisfying an increasingly felt want among teachers, viz., of an exposition of the elements of mental science in their bearing on the work of training and developing the minds of the young." Hence, in this particular volume we have a contribution rather to the science of education than to that of psychology. The larger work, though not by any means destitute of educational applications, is to be looked to primarily for the author's views upon the theoretical aspects of mental science. The aim of the newer book is practical. It is to be classed in the same category, for example, with Bain's "Education as a Science," though quite a different work from the latter in plan and execution. Mr. Sully condenses the principles of mental science, and shows what bearing those principles and the facts of which they are generalizations have upon the teacher's art. As its name imports, it is written not for the pupil chiefly, but for the instructor, or the student of educational methods.

Mr. Sully can hardly lay claim to the rank of a discoverer of new psychological truths. This, certainly, is no disadvantage to the success of a work like the "Teacher's Hand-Book." What is wanted is, the ascertained and accepted, so that the teacher may know what science, as knowledge verified, declares about the mind and its operations. This want the author has evidently understood, for he has been successful in keeping within the bounds of legitimate science. Very little exception can be taken to his statements of psychological facts and principles. He is never dogmatic at disputed points, he has no metaphysical hobby which he is bent upon riding, indulges in no polemical discussions, but proceeds in a direct, simple, and effective manner to work out what he tells us in his preface are the objects of his book. No better proof, for instance, of the good sense of the writer can be adduced than the fact that, in treating of volition, there is actually no mention made of the controversies over the "freedom of the will." That expression, indeed, does not occur, nor does "free-will" in any metaphysical sense. We are sure the hackneyed dispute will never be missed, but the self-restraint indicated by this omission is as remarkable as it is praiseworthy.

We are not always quite satisfied, however, with the author's psychological enunciations. For illustration, we will mention his statements about association: he makes out plainly enough in his larger work that there are not three distinct modes of association, but that they can be reduced to one; and yet, with too much caution he sets forth in the "Hand-Book" three, *contiguity*, *similarity*, and *contrast*, because it is "usual" to do so. This is not a sufficient reason, especially when *contrast* has been clearly shown not to be an independent principle of association for as long a time as Professor Bain's "Senses and Intellect" and Herbert Spencer's "Principles of Psychology" have been published. Besides, to retain this as a mode of association is misleading. We do not associate by difference but by likenesses. Association is a process of integration. It is always and essentially what its name imports — assimilation. Representation, a differentiating power, brings up past experiences which association integrates and redintegrates with each other and with presentative experiences. The latter process is the assimilation of contiguities, a segregation and unification of similarities in experience. We think Mr. Sully might advantageously have elucidated in this manner the true nature of association and its connection with the general laws of evolution, since the notes he makes in the "Outlines of Psychology" show that he is alive to the objections that have been raised to the mode of statement he adopts. In fact, he allows their force. Why, then, retain what he does not believe in, merely because it is "usual"? We all concede that errors are common, but can not, therefore, argue that they should be persisted in.

We are inclined to charge our author also with an occasional sin of omission. We are surprised to find that he says so little about belief, for instance, since he has made the nature of that mental state or act a special study, as appears in one of his earlier works, "Sensation and Intuition," and also in the "Outlines of Psychology." In the "Hand-Book," however, there is little more than a passing allusion, in connection with the subject of doubt. The term *belief* is so universally employed in common and scientific use to indicate a certain mental attitude, or certain mental operations,

that, in a work of the character of the one before us, we think something more should have been said to show exactly what this attitude is, and to exhibit more fully the nature of the operations of our minds in *believing* or *disbelieving* anything. We consider that here Mr. Sully has carried condensation too far.

But as the main purpose of our author's work is in its educational applications, so in these lies its chief merit. There is a great deal of interesting observation about the development of the child's mind—as regarding imagination and reasoning, for example; and there are many fruitful suggestions respecting the proper methods to be adopted in promoting the growth of the mental powers and strengthening them. The whole subject of control of the emotions and their various uses is admirably handled. The pleasures of knowledge, the development of æsthetic taste, the erection, maintenance, and following of moral standards—all receive ample illustration with many precepts of practical value. We are glad to see the uses of obedience in childhood, as a means to self-control and to a well-balanced character, so correctly stated. We are very apt to find either the contention that there should be little exercise of authority on the one hand, or on the other that authority should still be controlling as an end in itself throughout adult life. The former idea leads to anarchy, the latter to despotism. This is what Mr. Sully says: "As already pointed out, an indispensable step in the formation of a sense of duty is the assertion and exercise of authority over the child, the making him feel that there is a higher will over his which he has to obey.

"It may safely be contended that obedience in the sense already defined is in itself a moral habit—forming, indeed, one chief virtue of childhood. . . . Nevertheless, it is a common and fatal error to regard obedience to personal authority as an end in itself. The ingredient in childish obedience which constitutes it a moral exercise is the dim apprehension of the reasonableness and moral obligatoriness of what is laid down. And the ultimate end of moral discipline is to strengthen this feeling, and to transfer the sentiment of submission from a person to a law which that person represents and embodies. . . . Commands are a scaffolding which performs a necessary temporary function in the building up of a self-sufficient habit of right conduct" (pp. 393, 394). This is very sensible and wholesome doctrine.

Altogether, Mr. Sully has produced an excellent book, of unique character in psychological works. There is no doubt that it supplies a genuine, not a fanciful need, nor is there any question of the scholarship of the author, or of his fitness to point out practical methods in education. He is himself an educator, and has the experience of the teacher in addition to the accumulations in knowledge of one who has made of the subject of psychology a life-long study. He has done his work so successfully that our thanks and our praise are very cordially, and, as we believe, deservedly, bestowed.

Triumphant Democracy: or, Fifty Years' March of the Republic. By Andrew Carnegie. New York: Charles Scribner's Sons. 1886. Pp. 509. Price, $2.50.

Mr. Carnegie has produced a very readable book, and one of which an American has reason to be proud as the tribute of one of her adopted citizens. The title suggests a panegyric, and the text does not belie it. The unparalleled material progress of the republic is recounted in the most exultant strain, and its political institutions are given unstinted praise. In comparison with those of the mother-country he finds the advantages all with us, and earnestly hopes that it will not be long before England will be remodeled upon our basis. The magic which has transformed a continent and given the world the strongest and wealthiest of nations he finds in the political equality of the citizens, and this is the thing he deems needful for England if she is to keep abreast of her young and powerful rival. He writes in no spirit of antagonism to England in recounting the triumphs of the English-speaking people upon this side of the Atlantic, but only wishes for her a future as pleasing. The relation of mother and child is the one he continuously holds up, and the drawing closer together of all English-speaking communities expresses his most ardent wish.

The volume would have unquestionably gained in value had Mr. Carnegie written in a more critical spirit, but it is perhaps just

as well that we should have, once in a while, as ardent an admirer and as firm a believer in our political faith as Mr. Carnegie, to recall us to a contemplation of our virtues. Of critics there will always be enough. The following summary of the results achieved by the republic during the first century of its existence well indicates the general tone of the volume:

"1. The majority of the English-speaking race under one republican flag, at peace.

"2. The nation which is pledged by act of both parties to offer amicable arbitration for the settlement of international disputes.

"3. The nation which contains the smallest proportion of illiterates, the largest proportion of those who read and write.

"4. The nation which spends least on war and most upon education; which has the smallest army and navy, in proportion to its population and wealth, of any maritime power in the world.

"5. The nation which provides most generously during their lives for every soldier and sailor injured in its cause, and for their widows and orphans.

"6. The nation in which the rights of the minority and of property are most secure.

"7. The nation whose flag, wherever it floats over sea and land, is the symbol and guarantor of the equality of the citizen.

"8. The nation in whose Constitution no man suggests improvement; whose laws as they stand are satisfactory to all citizens.

"9. The nation which has the ideal second chamber, the most august assembly in the world—the American Senate.

"10. The nation whose Supreme Court is the envy of the ex-prime minister of the parent-land.

"11. The nation whose Constitution is 'the most perfect piece of work ever struck off at one time by the mind and purpose of man,' according to the present prime minister of the parent-land.

"12. The nation most profoundly conservative of what is good, yet based upon the political equality of the citizen.

"13. The wealthiest nation in the world.

"14. The nation first in public credit and in payment of debt.

"15. The greatest agricultural nation in the world.

"16. The greatest manufacturing nation in the world.

"17. The greatest mining nation in the world."

California, from the Conquest in 1846 to the Second Vigilance Committee in San Francisco. By Josiah Royce. Boston and New York: Houghton, Mifflin, & Co. Pp. 513, with Map. Price, $1.25.

This history belongs to the "American Commonwealths" series, of which Mr. Horace E. Scudder is the editor, and is presented as a study of American character. That character, earnest, practical, and always self-possessed, is strikingly exemplified in the manner in which a prosperous and advancing State has been organized out of the chaos that prevailed during the earlier years of the California settlement. In studying the subject, the social condition has been throughout of more interest to the author "than the individual men, and the men themselves of more interest than their fortunes, while the purpose to study the national character has never been lost sight of. Through all the complex facts that are here set down in their somewhat confused order, I have felt running the one thread of the process whereby a new and great community first came to a true consciousness of itself. The story begins with the seemingly accidental doings of detached but in the sequel vastly influential individuals, and ends just where the individual ceases to have any great historical significance for California life, and where the community begins to be what it ought to be, viz., all-important as against individual doings and interests."

Food Materials and their Adulterations. By Ellen H. Richards, Instructor in Sanitary Chemistry in the Massachusetts Institute of Technology, author of "Chemistry of Cooking and Cleaning." Boston: Estes & Lauriat. 1886.

This work is the result of ten years' experience in laboratory examination of food materials, along with careful attention to the literature of the subject, both at home and abroad. It makes no claim to originality, but is intended to give useful information in a form adapted to schools and the home—that is, without technicalities or

unnecessary details. Chapter I is an earnest plea for the education of girls in this vital subject of the quality of food; II considers water, tea, coffee, and cocoa; III, cereal foods; IV, milk, butter, and cheese; V, sugar; VI, canned fruits and meats; VII, condiments; VIII, perishable foods and the means for preserving them; IX, other materials used in cooking; X, principles of diet. Mrs. Richards regards scientific housekeeping as "the duty of the rich and the salvation of the poor." She tells of a young woman who lived and flourished "on corn-meal, cooked in various ways, for a whole year, with only a dinner every Sunday at a friend's house. She kept well and hearty on a peck of Indian-meal a month; so that her whole living cost only about ten dollars a year, as she prepared it herself." Twenty hours a week spent in making pies, cakes, and puddings, at a cost of five dollars, when an equivalent in fruit for dessert can be had for three dollars, with fuel and service saved as well as time, is given as one of the instances of thoughtless waste in which current household management abounds. The excellent works put forth by Mrs. Richards and her example of a life devoted to high practical ends must help on the time when housekeepers will respect their calling, become intelligent and interested in it, and then we may hope that their best thought will be devoted to its improvement.

Bulletin of the Scientific Laboratories of Denison University, Granville, Ohio. Edited by Professor C. L. Herrick. Pp. 136, with Plates and Tables. Price, $1.25.

The editor, assuming that every well-conducted institution of learning should form a recognized center of scientific activity, the "Bulletin" is intended to represent the life of the college in its scientific departments. It contains papers, most of them well and clearly illustrated, on the "Osteology of the Evening Grossbeak"; "Metamorphoses of Phyllopod Crustacea"; "Superposed Buds"; "Limicole, or Mud-living Crustacea"; "Rotifers of America, with Descriptions of a New Genus and Several New Species"; "The Clinton Group of Ohio, with Descriptions of New Species"; "A Compend of Laboratory Manipulation," presenting in concise form the methods which have proved to be of greatest service; a condensed translation of Eugene Hussak's tables for the determination of rock-forming minerals; and a brief account of the natural history department of the university.

Food Consumption. By Carroll D. Wright. —Chemical Analysis and Treatment. By Professor W. O. Atwater. Boston: Wright and Potter Printing Company. Pp. 90.

This is the part of the report of the Massachusetts Bureau of Statistics that relates to the quantities, costs, and nutrients of food materials. The investigation to which it relates was undertaken in the conviction that much money is wasted in the purchase of food that is lacking in the elements of nutrition, and that the incomes of working-men might be made far more effective if their food were provided in accordance with the results of scientific research. To aid in determining this point, a number of schedules of dietaries, giving qualities and costs of food of people of limited incomes were collected, and the constituents subjected to analysis. The results of the analyses are here presented in a comparative form, as between the constituents themselves, and as compared with other dietaries and recognized standards.

Hand-Book of Plant Dissection. By J. C. Arthur, M. Sc., Botanist to the New York Agricultural Experiment-Station; Charles R. Barnes, Professor of Botany in Purdue University; and John M. Coulter, Ph. D., Professor of Botany in Wabash College, Editors of the "Botanical Gazette." New York: Henry Holt & Co. 1866.

By the method of this book, plants are first subjected to "gross anatomy," as it is called, or observation, with the aid only of a hand-lens; and then, passing to "minute anatomy," every part is subjected to the compound microscope. The apparatus, reagents, and materials required, have been made as few as possible, and the directions for their use are so clear and intelligible, that they must have been derived from actual and extended experience in giving this form of instruction. The subjects selected for study are common plants, to be found

everywhere, from the green slime on the north side of old fences and the trunks of trees, to the higher or flowering plants. Each one of these examples is studied closely and critically in all its parts. Explicit directions are given, but the student is warned against depending on the manual rather than working out results of his own. By this thorough study of a few examples, the main features of plant-anatomy are made familiar, at the same time that habits of independent observation and judgment are being established. Every school where botany is studied should have provision for getting such a first-hand knowledge of plant-anatomy as is contemplated in this excellent manual. The necessary outfit for such a course of study is carefully stated, but we find no reference to its probable cost—a very practical question, that will doubtless arise in the minds of many persons who are interested in educational progress.

Protection or Free Trade. An Examination of the Tariff Question, with Especial Regard to the Interests of Labor. By Henry George. New York: Henry George & Co. 1886. Pp. 356. Price, $1.50.

This is a discussion of the tariff question from Mr. George's well-known point of view, that nothing short of the abolition of private property in land can greatly benefit the laboring classes. The author traverses the ground usually gone over in economic works in the consideration of this subject, but by his fresh and vigorous treatment he lends an interest to it not usually found in such discussions. He arrives at the same conclusions in regard to the futility of tariffs to benefit industry as does every competent economist who has investigated the question, but, unlike most advocates of free trade, in current discussions, does not believe in the step-by-step process of reaching the end in view.

"Tariff for revenue only," he contends, is about the most cumbrous and costly method of raising a revenue and is indefensible on economical as well as political grounds. He therefore advocates immediate and unqualified free trade, and in doing so feels assured that the change would not involve the country in any great industrial convulsion. Even if it should, he holds that it is far better for the laboring classes that this should be short and sharp, than that it should extend over a long period, in which there would be time to shift almost if not the whole burden upon their shoulders.

Mr. George does not rest his discussion with the presentation of the generally accepted free-trade arguments, and from his point of view he could not logically stop short of the length to which he has carried it. Protection to the wage-earning class is the professed object of the tariff, and that given to the employer is only a means to this end. It was therefore incumbent upon Mr. George to consider the extent to which free trade can benefit the working-man under present industrial conditions, and to show further what the conditions of industry must be which would give it the greatest value for him. In taking up this portion of his subject he considers the cause of the hold protection still retains upon the industrial nations of the world after fifty years of discussion, and finds it in the belief that protection "makes work," and that this is just what the laboring man wants. Under the changed industrial conditions he proposes he believes the distribution of wealth would be so changed in favor of the laboring classes that the problem of getting work would cease to be of serious import, and the working-man would then see clearly the essential viciousness of trade restrictions. He closes the volume with an appeal to the working-classes to push the free-trade issue into politics, and sees in its triumph the entering wedge which shall pave the way for his special reform.

First Annual Report of the Commissioner of Labor. By Carroll D. Wright.—Industrial Depressions. Washington: Government Printing-Office. Pp. 485.

The Bureau of Labor was established by act of Congress of June 27, 1884, and the Commissioner was appointed in January, 1885. The Commissioner projected for the first year's work of the Bureau the collection of information relative to industrial depressions, by means of investigations which should comprehend a study of the character and alleged causes of the present crisis, whether the causes were contempo-

raneous in the great producing countries, and whether, as to duration, severity, and periodicity, they had been similar in such countries. The outline also comprehended the collection of data relating to the variation of wages in different countries and in different parts of this country, variations in the cost of living in the same localities, and in the cost of production, with all such alleged causes of industrial depressions as might offer opportunity for illustration through classified facts, and the suggestion of remedies for depressions. Five agents were employed in the investigation in foreign countries—Great Britain, France, Belgium, Germany, Switzerland, and Italy—and fifteen in this country. The results of their inquiries are given in detail, and summarized in this report.

Socialism and Christianity. By A. J. F. Behrends, D. D. New York: Baker & Taylor. Pp. 308. Price, $1.50.

Dr. Behrends was invited by the Trustees of the Hartford Theological Seminary to deliver a course of lectures before the students of that institution on the "Social Problems of our Time." This book is the fruit of his studies on the subject, in which he spent a year. In the constructive part of his work, he claims that he has been careful to maintain an independent position. "I have copied from no one, and have frequently found myself in agreement and at variance with the most opposite schools of thought. The method of criticism was fixed for me in my conception of Christianity, and in my settled conviction of its adequacy to solve the pending social problem." In the successive chapters are considered social theories and their history, the assumptions and economic fallacies of modern socialism, the rights of labor, the responsibilities of wealth, the personal and social causes of pauperism, its historical causes and its cure, the treatment of the criminal classes, and "Modern Socialism, Religion, and the Family." The last-named, the closing chapter, is marked by an extended discussion of the true doctrine of the family, which "grew out of the deepening conviction that, in all radical and permanent social reform, a high view of the sanctity of marriage must lead the way."

Political Science Quarterly. Edited by the Faculty of Political Science of Columbia College. March, 1866. Boston: Ginn & Co. Pp. 152. Price, $3 a year; 75 cents a single number.

The "Political Science Quarterly" is intended to furnish a field for the discussion of political, economic, and legal questions—the latter heading embracing chiefly questions of constitutional, administrative, and international law, from the scientific point of view, and by a scientific method. Such topics will be preferred as are of present interest in the United States, but no topics will be excluded which can throw light upon the problems and tendencies of our own country. The present number contains an introductory article on "The Domain of Political Science," by Professor Munroe Smith; "The American Commonwealth," by Professor John W. Burgess; "Collection of Duties," by Frank J. Goodnow; "American Labor Statistics," by Professor Richmond M. Smith; "Legislative Inquests," by Frederick W. Whitridge; "The Berlin Conference," by Daniel De Leon; and reviews of new books.

Persia: The Land of the Imams. By James Bassett. New York; Charles Scribner's Sons. Pp. 343. Price, $1.50.

The author is a missionary of the Presbyterian Board of Missions, and gives in this work a narrative of travel and residence during fourteen years, or from 1871 to 1885. In the first eleven of the sixteen chapters of the book, he gives narratives of extended tours, and such information as seemed to him to be profitable and interesting. The itineraries include the journey from Constantinople to Persia by way of Trebizond and Erzeroum, and to Oroomiah, with accounts of the Nestorians; from Oroomiah to Teheran, with a description of that city; a journey to Ispahan; from Teheran to the Black Sea and back; and from Teheran to Mashhad. In the remaining chapters is given a general review of Persian affairs, including facts which the author obtained in his travels, chiefly from his own observations. They relate to the general account of the country and its social and economical condition, its government, the prevailing religions, and the condition and prospects of missionary work there. Concerning the

value of our diplomatic representation there under Mr. Benjamin, we are informed that "it could not be otherwise than that the arrival (in June, 1883) at the capital of a legation of the United States should create in the mind of the Shah and of the officers of the Persian Government a greater interest in America and Americans. The missionaries were in a position to reap the benefits of this interest, and the minister, in the brief period of his residence in Teheran, was able to secure for them, from the Persians, some valuable concessions."

Outlines of Geology. An Introduction to the Science for Junior Students and General Readers. By James Geikie, LL. D., F. R. S. Illustrated. London: E. Stanford. Pp. 424.

In this work, as in the "Class-Book of Geology," by Archibald Geikie, noticed elsewhere in these pages, the plan pursued has been first to thoroughly acquaint the student with the various agents that effect geological changes, and their modes of action, and only then to pass on to the study of the different geological systems. The first half of the book is given to a careful investigation of the work performed by the different forces of Nature. This is discussed under two heads, viz.: "I. Epigene, or Superficial Action"; and, "II. Hypogene, or Plutonic Action."

The first of these divisions treats of the action of the atmosphere, of water, and of plants and animals, while the second studies the action of the subterranean forces.

The work done by terrestrial waters in effecting important changes receives due attention; rain, underground water, brooks and rivers, lakes, each is considered at length. Two chapters are devoted to the geological action of ice; another to the influence of the sea.

A review of the part performed by plants and animals in geological changes is followed by a chapter on the classification of the products of surface-action.

The second division, given to the consideration of subterranean action, embraces the subjects of volcanoes and volcanic products; the mineralogical composition of vitreous and crystalline igneous rocks; their petrological character; movements of the earth's crust; the structure of rock-masses; ore-deposits, etc.

A chapter on paleontological geology forms the introduction to historical geology. The divisions here made are four in number: the primary or palæozoic, the secondary or mesozoic, the tertiary or cainozoic, and the quaternary or post-tertiary. Each of these is studied in turn. Numerous illustrations are given of the fossils occurring in and characteristic of the different periods. In fact, these illustrations, together with some others, inserted in the first part of the book, constitute one of the great attractions of this volume.

Class-Book of Geology. By Archibald Geikie, LL. D., F. R. S. Illustrated. London: Macmillan & Co. Pp. 516. Price, $2.60.

This volume is intended to complete a series of educational works on physical geography and geology, projected by the author a number of years ago. It is a book written by the light of experience gained in practical teaching, and the writer's aim has been to produce a work that should awaken an interest in and love for the science of which it treats, and thus incite to original study and research.

The book is divided into four parts, and embraces a consideration of the materials for the history of the earth, a study of rocks, and how they tell the history of the earth, an account of the crust of the globe, and a careful analysis of the geological record of the history of the earth.

The influence of the atmosphere in changes affecting the surface of the earth, and the effects produced by water, under various conditions, take up the first few chapters. These are followed by an essay on "ice-records"—a history of the glacial epoch—and then comes an interesting description of how plants and animals inscribe their records in geological history.

In discussing the more important elements and minerals of the earth's crust, brief reference is made to the mode of occurrence, formation, and properties of each, and the crystalline form and the origin of crystallized minerals are carefully studied. Under the head of "The more important Rocks and Rock Structures" is

considered the question of how minerals are combined and distributed so as to build up the earth's crust; attention is here especially directed to the knowledge of rock-structure gained within recent years by the use of the microscope.

Part III treats in turn of the sedimentary and the eruptive rocks. Of the former, the original structure, the association of strata, the chronological value of strata, etc., . . . are reviewed; in connection with the latter, the formation of mineral veins—by deposition from the molten state and by deposition from water-solution—is described.

Fossils, which may be termed "the labels of the strata," receive the share of attention due their importance, and are studied as indicating former changes in geography, former conditions of climate, and the chronological sequence of geological formations.

The rest of the book is given to the study of the main divisions of the geological record—that is to say, to a systematic review of the stratified formations of the earth's crust.

An appendix, furnishing an outline of the classification of the vegetable and the animal kingdom will prove convenient for reference, and the many illustrations embodied in the text of the volume will be a welcome aid to the student.

The Wealth of Households. By J. T. Dawson. Oxford (England): At the Clarendon Press. Pp. 368.

This is essentially a book on political economy, the substance of which was first put together, more than twenty years ago, by way of using the experience of a man of business in the education of his children. It was afterward recast and delivered as lectures, and then printed. Having become out of print, it has been entirely rewritten, as a text-book—and with especial reference to some of the economic questions of the day. The principles of the subject, in its several departments, are presented in brief, pointed paragraphs, which are often short enough to be maxims. Considering the situation of workmen, the author deplores subjection alike to capital and to the trades-union; and advises workmen to try to make themselves independent by getting a year's subsistence ahead. This is not beyond their means, for thousands of the class are daily paying the price of it from means drawn wholly from weekly wages.

Manual Training. The Solution of Social and Industrial Problems. By Charles H. Horn. Illustrated. New York: Harper & Brothers. 1886.

The contents of this volume are briefly summarized by the author as consisting, first, of a detailed description of the various laboratory class processes from the first lesson to the last in the three years' course of study at the Chicago Manual Training School. The second division is "an exhaustive argument *a posteriori* and *a fortiori* in support of the proposition that tool-practice is highly promotive of intellectual growth, and in a still greater degree of the up-building of character." The third division deals with the history of civilization as related to methods of education, and in the fourth part the history of manual training as an educational force is briefly presented.

Color Studies. By Thomas A. Janvier. New York: Charles Scribner's Sons. Pp. 227.

A book of stories of artist-life, to which an allegorical air is given by the characters bearing the name of artists' colors. According to its motto, the book is without moral or purpose, but "whichever way you look" in it, "you'll only find—a pair of lovers."

A Popular History of Astronomy during the Nineteenth Century. By Agnes M. Clerke. New York: Macmillan & Co. 1886. Pp. 468. Price, $4.

"The present volume does not profess to be a complete or exhaustive history of astronomy during the period covered by it. Its design is to present a view of the progress of celestial science on its most characteristic side since the time of Herschel." These words, taken from the preface, clearly present the scope and aim of the book before us.

The introduction refers briefly to the three kinds of astronomy distinguished. The first of these is known as observational or practical, the second is called gravita-

tional or theoretical, and was founded by Newton; and the third is best described by the term physical and descriptive astronomy. A short sketch is given of the progress of the science during the eighteenth century, and the rapid advance during the nineteenth century is broadly outlined.

The book is divided into two parts. The first of these treats of the progress of astronomy during the first half of the nineteenth century, the second is devoted to the progress made in recent years. The chapters in Part I embrace the foundation of sidereal astronomy, progress of sidereal astronomy, progress of knowledge regarding the sun, planetary discoveries, comets, and instrumental advances.

Part II discusses, among other topics, the foundation of astronomical physics, solar observations and theories, recent solar eclipses, spectroscopic work on the sun, the temperature of the sun, planets, and satellites, recent comets, stars, and nebulæ, and methods of research.

It has been the intention of the author to secure the materials needed from the original authorities whenever possible, and the large number of references given throughout the work will prove of great value and assistance to students.

Considerable attention has also been paid to the biography of the more eminent workers in this field, and the story of the life of many of these men strikingly enforces the lesson that great results may be reached even under the most discouraging circumstances by honest devotion to the work in hand, joined with tenacity of purpose.

Forests and Fruit-Growers. By Abbot Kinney, of Kinneyloa, San Gabriel, California. Pp. 5.

This is an address which was prepared and read at the California Fruit-Growers' Convention, by request of the State Board of Horticultural Commissioners. It presents the damage which has been produced in consequence of the destruction of the forests in different parts of the world. Accompanying his address, Mr. Kinney sends an article on "Floods and Fires," in which he gives the matter a local application, exhibiting the injury that has been wrought in the neighborhood of his own home by forest destruction, and shows that more of the same kind may be anticipated from continued progress in the wasting work.

Circulars of Information of the Bureau of Education, 1885. Nos. 3 and 4. Washington: Government Printing-Office. Pp. 55 and 56.

Circular No. 3 is a review of the Reports of the British Royal Commissioners on Technical Instruction, with notes, by the late Charles O. Thompson, of the Rose Polytechnic Institute, Terre Haute, Indiana. No. 4 is an account of the organization and statistics of education in Japan.

United States Government Publications. Monthly Catalogue. Vol. I. No. 12. Washington, D. C.: J. H. Hickcox. Pp. (of the volume) 292. Price, $2 a year.

It is believed that, in the volume of the Catalogue now completed, no Government publication of the year has escaped notice. The number of publications mentioned is approximately given at three thousand. A copious index is provided. The Catalogue will be continued, though the subscriptions to it have not yet been flattering.

The Life and Genius of Goethe. Edited by F. B. Sanborn. Boston: Ticknor & Co. Pp. 454.

This volume is composed of the lectures on Goethe, or rather, those of them which were available for publication, which were delivered at the Concord School of Philosophy in July, 1885. The list includes lectures on Goethe's youth, by Professor H. S. White; his self-culture, by John Albee; his Titanism, by Thomas Davidson; Goethe and Schiller, by Rev. C. A. Bartol; Goethe's "Märchen," by Rev. F. H. Hedge; his relation to English literature, by F. B. Sanborn; "Goethe as a Playwright," by W. O. Partridge; "Das Ewig-weibliche," by Mr. E. D. Cheney; "The Elective Affinities," by S. H. Emery, Jr.; "Child-Life as portrayed by Goethe," by Mr. C. K. Sherman; "History of the Faust Poem," by D. S. Snider; "Goethe's Women," by Mrs. Julia Ward Howe; and "Goethe's Faust," by W. T. Harris. To these are added, as an introduction, an account of the Goethe Society and the Goethe Archives, and bibliography of Goethe's works, of works on Goethe, and of papers on Goethe, and two portraits of the poet.

An Apache Campaign in the Sierra Madre. By John G. Bourke. New York: Charles Scribner's Sons. Pp. 112. Price, $1.

This is a spirited and very interesting account of the expedition, under General Crook, in pursuit of the hostile Chiricahua Apaches in the spring of 1883. Its purpose is simply to outline some of the difficulties attending the solution of the Indian question in the Southwest, and to make known the methods employed in conducting campaigns against savages in hostility. The author makes it understood that for the better accomplishment of this object he has submitted an unmutilated extract from his journal kept during the whole period involved. The record having been kept in a style free from literary affectations, presents picturesquely the life of the campaign. The illustrations, showing the customs and arts of the Apaches, add much to the value of the book.

John Cabot's Landfall in 1497 and the site of Norumbega. By Eben Norton Horsford. Cambridge: John Wilson & Son. Pp. 39, with Maps.

John Cabot, in 1497, came upon a spot somewhere in New England which he called, after the designation given by the Indians, Norumbega. The French afterward built a fort called Norumbega, on a river of the same name. The site has since been lost, but has usually been assigned to the banks of the Penobscot, although for reasons not judged sufficient. Mr. Horsford believes that he has found both Norumbegas—Cabot's on Salem Neck, and the French fort and town, on Charles River, between Riverside and Waltham, Massachusetts, where he discovered the remains of the fort. If the first determination is correct, Cabot is proved to have preceded Columbus in the discovery of (continental) America.

Report of the Smithsonian Institution for 1884. Washington: Government Printing-Office. Pp. 903.

This volume contains the usual official reports of the proceedings of the Board of Regents, of the Executive Committee on financial affairs, and of the secretary, giving an account of the operations and condition of the Institution for the year 1884, with the statistics of collections, exchanges, etc. To these are added, in the Appendix, a record of recent progress in the principal departments of science, and special memoirs, original and selected, on various subjects. Among the memoirs are several papers of particular interest in anthropology, among which we may mention Mr. Vreeland's on the antiquities at Pantaleon, Guatemala—very curious sculptured figures, unique in American aboriginal art—and Professor Mason's account of the Guesde collection of antiquities in Pointe-à-Pître, Guadeloupe.

PUBLICATIONS RECEIVED.

Darling, Charles W. Anthropophagy, historic and pre-historic. Utica, N. Y. Privately printed. Pp. 47.

Shufeldt, R. W. Science and the State. Pp. 10.

Carter, J. M. G. The Relation of Ætiology to Evolution. St. Louis. Pp. 8.

The Journal of Heredity. Edited by Mary Weeks Burnett, M. D. Quarterly. Chicago. Pp. 48. $1 a year.

Society for the Promotion of Agricultural Science. Proceedings of the Sixth Meeting, Ann Arbor, Mich. 1885. B. D. Halsted, Ames, Iowa, Secretary. Pp. 59.

Hilgard, Eugene W. Report on the Viticultural Work of the College of Agriculture, University of California. 1883–1885. Pp. 210.

Proceedings of the Colorado Scientific Society. 1885. Whitman Cross, Secretary. Pp. 36.

Mills, T. Wesley, Montreal. The Action of Certain Drugs and Poisons on the Heart of the Fish. Pp. 7.

Curtis, George T., and Richards, F. S. Arguments, in the Supreme Court of the United States, on Religious Liberty and the Rights of Conscience. Pp. 80.

Curry, S. S., Boston. School of Expression. Second Annual Catalogue. Pp. 12.

Von Taube, G. The Fitting School, Gramercy Park, New York. Pp. 86.

Ryder, John A. On the Development of Viviparous Osseous Fishes and of the Atlantic Salmon. Washington: Government Printing-Office. Pp. 35. With Seven Plates.

Cornell University. Proceedings in Memory of Louis Agassiz and in Honor of Hiram Sibley. 1885. Pp. 38.

Foster, Michael, and others. "The Journal of Physiology." Vol. VII, No. 1. Cambridge, England. Pp. 80. With Three Plates. $5 a volume.

Martin, H. N., and Brooks, W. K. Studies from the Biological Laboratory of Johns Hopkins University. Vol. III, No. 7. Baltimore: N. Murray. Pp. 50. With Plates. 30 cents. $5 a volume.

Boston Society of Civil Engineers. Comparative Size of Metric and Old Units, and Report on Weights and Measures. Pp. 28.

United States Bureau of Statistics Quarterly Report of Imports, etc., to March 31, 1886. Washington: Government Printing-Office. Pp. 180.

Some Funny Things said by Children. New York: J. S. Ogilvie & Co. Pp. 62. 10 cents.

"Journal of the American Chemical Society." New York: Monthly. Pp. 24. $5 a year.

Wood, E. A., M. D., Philadelphia. Heredity and Education. Pp. 12.

Frazer, Persifor. The Application of Composite Photography to Handwriting. Pp. 10.

Purdue University, Lafayette, Ind. School of Pharmacy. Third Annual Announcement. Pp. 8; Bulletin No. 1. Pp. 22.

School of Pharmacy, University of Michigan. Annual Announcement for 1886-'87. Ann Arbor, Mich. Pp. 44.

Marcou. Annotated Catalogue of the Published Writings of Charles Abiathar White. Washington: Government Printing-Office. Pp. 64.

Curtiss, Romaine J., M. D., Joliet, Ill. State Control of Medical Education and Practice. Pp. 32.

Skidmore, Professor S. T., Philadelphia. The Burial of an Ass. Pp. 15.

Austen, Peter P., New Brunswick, N. J. The Purification of Water by Alum. Pp. 4. Dinitrosulphocyanbenzene. Pp. 3.

Historical Society of Southern California. Los Angeles. January, 1886. Pp. 43.

Hartwell, Edward Mussey. Physical Training in American Colleges and Universities. Washington: Government Printing-Office. Pp. 183. With Plates.

Wadsworth, M. E. On a Supposed Fossil from the Copper-bearing Rocks of Lake Superior. Pp. 4. List of Publications, 1877-1885. Pp. 3.

Kennedy, J. F., M. D. Typhoid Fever. Pp. 14. Health Laws of the State of Iowa. 1886. Pp. 45.

Smithsonian Accounts of Progress in 1885. Geography, by J. King Goodrich, pp. 36; Chemistry, by H Carrington Bolton, pp. 50; Astronomy, by William C. Winlock, pp. 114; North American Invertebrate Paleontology, by John Belknap Marcou, pp. 46; Anthropology, by Professor Otis T. Mason, pp. 56; Mineralogy, by Professor E. S. Dana, pp. 26; Vulcanology and Seismology, by Professor Charles G. Rockwood, Jr., pp. 23; Physics, by Professor George F. Barker, pp. 60. Washington: Government Printing-Office.

Warden, Florence. Doris's Fortune. New York: D. Appleton & Co. Pp. 194. 25 cents.

Cassell's National Library. No. 20. The Battle of the Books and other Short Pieces. By Jonathan Swift. Pp. 192. Poems. By George Crabbe. Pp. 192. Egypt and Scythia described by Herodotus. Pp. 192. 10 cents each.

Tchernychewsky, N. G. What's to be Done? Translated by Benjamin R. Tucker. Boston: Benjamin R. Tucker. Pp. 329. $1.

The Cognitive Powers. By James McCosh. New York: Charles Scribner's Sons. Pp. 245. $1.50.

The Mystery of Pain. By James Hinton, M. D. Boston: Cupples, Upham, & Co. Pp. 121.

Kedzie, J. H. Solar Heat, Gravitation, and Sun-Spots. Chicago: S. C. Griggs & Co. Pp. 304. $1.50.

Chamberlin, Edwin M. The Sovereigns of Industry. Boston: Lee & Shepard. Pp. 186.

Harris, Amanda B. Old School-Days. Boston: Interstate Publishing Company. Pp. 109. 60 cents.

Kirke, Edmund. The Rear-Guard of the Revolution. New York: D. Appleton & Co. Pp. 317. $1.50.

Hoffman, K. B., and Ultzmann, R. Analysis of the Urine. New York: D. Appleton & Co. Pp. 310. With Eight Plates.

Steam-heating Problems. New York: The Sanitary Engineer. Pp. 233. $3.

Logan, John A. The Great Conspiracy. Its Origin and History. New York: A. R. Hart & Co. Pp. 810. With Plates.

Abbott, Helen C. de S. Preliminary Analysis of the Bark of Fouquieria splendens, pp. 8; Yucca angustifolia, pp. 32.

POPULAR MISCELLANY.

The Nineteenth Century Club.—The Nineteenth Century Club has completed its fourth season of lectures and discourses with undiminished interest on the part of its constituency. The organization has been true to its idea of securing the presentation of all sides of important questions. Besides its social success, its general intellectual and moral influence has been salutary. In the discussions just concluded the conservative side of thought has been represented by the Rev. Mr. Haweis, Rev. William Lloyd, Rev. Dr. Edward McGlynn, President McCosh, the Hon. C. M. Depew, F. R. Coudert, and President Porter as leading speakers. The views of President Eliot, of Harvard, were controverted by President Porter and Dr. McCosh. President Porter also had a discussion on "Evolution" with Professor E. S. Morse, of Salem, and Professor H. Newell Martin, of Johns Hopkins University, but his address took up so much of the evening that the other side had no opportunity to be heard with corresponding fullness.

New Light on "Arbitration and Conciliation."—Much has been written on the supposed labor question which the events of the last six months have made obsolete. Of this kind is a large part of "a plea for arbitration and conciliation," as embodied in a pamphlet on "Labor Differences and their Settlement," by Mr. Joseph D. Weeks, of Pittsburg, which has been sent us, bearing the imprint of the Society for Political Education. If workmen were always the gentle, much-enduring lambs that this author assumes them to be, there would be a place to make the peaceful ways of settlement between them and their employers which he suggests the rule. But where can arbitration and conciliation come in in such cases as the New York Steam-Heating Company and the Gray and the Landgraf boycotts, and the Texas Pacific and Third Avenue and Lake Shore Railroad strikes and their attendant "tie-ups"? These events have cast a new light on the matter; and those writers who are advising employers to submit the control of their concerns to outside organizations and are asserting the equal

right with employers to "determine" of men who are ready to destroy the establishment if it does not discharge its most faithful hands or overlook the transgressions of its unfaithful ones at their bid, will have to stand in the background till workmen have learned the duties they owe to one another and to society.

The "Profits" of Silk-Culture.—We published an article, last month, entitled "An Experiment in Silk-Culture," in which the writer made it very apparent that the business in this country, even when conducted with the most painstaking care, is likely to prove anything but a paying venture. Here is more testimony to the same effect, from a correspondent of the "Chicago Inter-Ocean": "Had I a pen of fire, and the sky for a scroll, and could I fly on the wings of the wind, I would at once start on my 'mission of mercy,' and, soaring through space from our blue Susquehanna to the mighty Pacific, I would inscribe in my flight in burning letters across our land, 'Let silk-culture most severely alone!' I know whereof I speak. I tried it to perfection under the most auspicious and exceptionally favorable circumstances—with every means and appliance at hand for 'clearing' two hundred dollars in the six weeks required to attend to the 'crop.' Within thirty miles of a market for the cocoons, with every surrounding the most encouraging, my hopes were high—but it was all a dead loss of time and money and work. It all ended in just forty-five cents worth of cocoons! I know how plausible it looks and reads. I know the inducements held out by silk-culture associations. I know, too, that the whole thing is as empty as a last year's bird-nest, and I, who have been so severely 'burned,' would fain caution others about going near the fire." The "Boston Herald" takes the same view, and is equally emphatic. It says: "The pleasant romance about the money made by girls throughout the country in raising silk comes to us every spring in an Associated Press dispatch, stating that the Agricultural Department is distributing silk-worm eggs to sanguine and enthusiastic applicants. When these worms are taught to look after their own sanitary arrangements, and, like the industrious ant, to garner food for their ravenous appetites, then the question of giving them the use rent free of some deserted shed or barn, in the hopes of getting a slight return for such worthless real estate, may be considered. Until the habits of these helpless and hungry paupers are improved, however, we advise all those who place the slightest value on their time and patience to shun the industry (an industry it is, with a vengeance!) as they would the advice of a quack advertisement. A few eggs will give one an entertaining and instructive lesson in natural history; an ounce of eggs will lead to trouble and vexation of spirit, an exasperating expenditure of time and patience, and absolutely no return, even for the rent of a wood-shed."

Parsee Children.—According to a writer in the "Westminster Review," when a child is born in a Parsee family, the exact time of its appearance is recorded, to a second. On the sixth night of its life, paper, pen, and ink, with some red powder and a cocoanut, are placed at the bedside of the child, so that "the goddess who presides over the infant" may record its destiny. In a few days an astrologer—it does not particularly matter of what religion he may be—is called in to cast the babe's nativity from the carefully recorded date of its birth. By the light of this sort of horoscope, he announces the names from which a choice may be made for the child, according to their affinity with the stars that were in the ascendant at the time of its birth. The Parsees having no fixed surnames, the son adds the name thus given him to the name which was similarly given to his father, dropping the grandfather's name which the father had assumed. If he be named Ardeshir and his father was named Framji, he becomes Ardeshir Framji. If his child, again, be named Pestanji, he is distinguished as Pestanji Ardeshir, and his son, in the following generation, might be Jehangir Pestanji. The Parsees possess in all about forty-nine names of Persian and twenty of Hindoo origin; hence there are always many persons bearing identical names. Further to distinguish between them, it has become customary to take as an *atak*, or distinguishing suffix, the name of a man's calling. So we may have Manakji Kavasji Su-

tar, or Manakji, the son of Kavasji, the carpenter. At the age of about seven years, the child receives the investiture of the holy shirt and girdle, accompanied with ceremonies calculated to impress him with the solemnity of the act, among which is his recital of the confession of faith in the Zoroastrian religion. The *sadarah*, or holy shirt, is a light, short muslin garment, worn next to the body; the *kosti*, or holy girdle, is a thin woolen cord of seventy-two threads, passed thrice round the waist and tied with four knots. The wearer, in tying the first knot, declares his belief in the doctrine of the one God, and at the second knot his faith in Zoroaster as the true prophet. In tying the last knot he says, "Perform good actions and abstain from evil ones." It is his duty, as soon as he has risen from sleep, to put on his *kosti*, wash his hands, and put wood on the fire. The astrologer has no place in the ceremony of investiture, but he presides over the arrangement of marriages, which take place early and usually between near relatives. The betrothal, the astrologer having pronounced the signs favorable, is made complete by the mere exchange between the parents of new dresses for the boy and girl.

Origin of Cancer.—Dr. H. Percy Dunn, of the West London Hospital, who has given attention to the study of cancer and the investigation of the causes of its increase in civilized countries, controverts the opinion that the disease is hereditary. The fact is admitted that cancer appears frequently consecutively in certain families, but this is not considered sufficient of itself to constitute an hereditary quality, while all the other characteristics of hereditary disease are absent. It fails to fulfill Quatrefages's definition of the hereditary quality, of becoming an agent of variation, and transmitting and accumulating the modifying actions of the conditions of life. But, while cancer is not transmissible as a disease, the predisposition to it may be inherited. The term predisposition is vague and hard to define, but may be described generally as "the shadow of a disease, as a disease without its substance—the reflection, as it were, in the offspring, distinct from the repetition of the morbid types common to one or both parents." The strongest element in the production of cancer is age, and it is most likely to appear between the thirty-fifth or fortieth and the sixtieth years. The disease may also be regarded as climatic or racial, prevailing most in the English climate and among the English people. It prevails most largely among women, and of them most with those who have had children. It is so prominently a nervous disease that Dr. Dunn gives his assent to the opinion that it may be and often is provoked by nervous shock. He, therefore, recognizes the expediency of preventing persons of middle age from being exposed to such shocks. In this relation to the nervous system, which is so trying in our busy age, is perhaps to be found the reason of the rapidly accelerated increase of cancer which has been lately remarked upon in England.

The King-Crab in New Waters.—Quite a sensation was stirred up among the fishermen of San Francisco on the 26th of May by the discovery of what was supposed to be a new crustacean. The creature was taken in the waters off the Farallone Islands by Captain Camilio, who was fishing there in his smack. When seen by some members of the United States Geological Survey, the "new crab" proved to be an old acquaintance, the *Limulus Polyphemus*, so common in the waters of the Eastern coast, where it is known as the king-crab on account of its great size, and the horse-foot crab because of its form. The living genus *Limulus*, if we reject two doubtful forms, has but three species—our own *L. Polyphemus*, the *L. moluccanus* of the Spice Islands, and *L. rotundicaudus* of the Chinese and the Japanese waters. Geologically considered, this strange creature has the highest antiquity of any of the crustaceans. And its place in nature is a problem of profound difficulty. Dr. Samuel Lockwood, so long ago as 1869, showed that in form the larval Limulus was identical with the trilobite. Since then embryological and anatomical study has shown that the animal is not a crab, and it is now even doubtful which it favors most, the position of an aquatic scorpion or an aquatic arachnidan; for it really seems to have structural elements of both the spider and the scorpion. It is also interesting to know that, while the trilobite

succumbed to geologic causes and became extinct, Limulus survived the most stupendous changes of land and sea. Whatever the species of the San Francisco specimen may be, as the first one taken in the Pacific waters it is highly interesting. But, supposing the specimen to be correctly determined as the species *Polyphemus*, that becomes a fact of very high significance. Although our Eastern king-crab survived the subsidence of large land areas, and the localizing of new seas, it was shut into a very circumscribed habitat — the eastern waters of the North Atlantic and the West Indies, and not even found in South America. In a word, it is an Atlantic form, and in its new habitat furnishes a fact as remarkable as if an African lion should be discovered in the American forests. It is almost a certainty that its appearance on the Pacific coast comes of an accidental introduction of some Limulus-eggs at the time that the United States Fish Commission introduced into the California waters a lot of lobsters taken from the East, as an experiment in stocking the Pacific coast. This was seven or eight years ago. The above fact is another illustration of the faunal and floral distribution brought about by man, often, as in this instance, by sheer accident. In the parlance of geologic time, it is a certainty that all plant and animal forms, however restricted their habitats in Nature may be, if they will bear acclimatizing, will soon become so cosmopolitan that their history as indigenes can only be obtained from libraries, where their life records shall be found as the published work of the naturalists of to-day.

Education and Crime.—The London "Spectator" remarks that the old idea that education would of itself extirpate crime has gradually been dissipated by experience. "It was a foolish idea *a priori*, for there is nothing in the mere development of intelligence to remove the original causes of crime or to cure either malice, or lust, or greed; and it died away before the evidence that education rather changes the form of some kinds of criminality than extinguishes criminality itself. The educated man swindles when the boor would steal, but the instinct of thievishness is the same in both, while greed is slightly increased by education." It does not even make all men intelligent, for "the new Anarchist faction, which rejects all the teaching, not only of history, but of the commonest facts of experience, and even the conclusions of arithmetic, is led by educated men, sometimes of high intellectual attainments." M. Elisée Reclus, author of most delightful and learned geographical books, is an anarchist; Prince Krapotkine, who counsels the destruction of society by force, is a man of unusual cultivation; Mr. Hyndman, who, while he disclaims anarchism, avows a desire to seize all capital, equalize all men, and compel all to labor, is a graduate of London University; and many of the cosmopolitan revolutionists are men familiar with many literatures. We have further been told, time and again, and are still told, by the advocates of popular education, that that would be in itself a strong guarantee for social order. Education has gone on diffusing its benefits among larger proportions of mankind; and now while New England, Scotland, and Prussia, formerly among the most educated states, were also the most orderly, there are in Germany five hundred thousand socialists"; and "all over the Western world, discontent with the order of society, especially upon points which can not be altered, appears to grow deeper and more violent." Thus, while education may still give us much in the end, "the old enthusiastic hopes from it were, as regards the time of their fruition, evidently illusory. It is no more a panacea than any other, and the good it does is as slow to develop itself as the good that rain does. We have all been just like the poor, and have expected pleasant results too soon, and from mere decrees, and from too little labor."

Traits of the Somaulis. — Mr. F. L. James has given an account of an exploration made early in 1884 into the Somauli country of East Africa, in which he penetrated to places where he was the first European visitor. The people seem in many ways to approach more nearly to the ancient Egyptians than any other African race with which the author is acquainted. Their swords are exactly like those used by the ancient Egyptians. Every Somauli carries two spears, a shield, and a short sword, and

the slightest difference of opinion with his neighbor prompts him to draw his sword or thrust with his spear. But, if he takes life, he, or his tribe for him, has to pay a heavy fine in camels. They can nearly always show several wounds, and are as proud of those which are behind as of those which are in front. They can also survive the gravest wounds, and recover quickly from injuries that would surely kill a European. They have quick tempers, which, when aroused, are absolutely beyond control, but, if they can once be got to listen to arguments, they are easily persuaded. They are great talkers, and every new plan is discussed for hours. The debaters sit in a circle, and divide themselves into parties, each appointing a spokesman; and he, holding a stick in his hand, will draw intricate geometrical designs in the sand while he holds forth on the subject in discussion. They are keenly sensitive to ridicule, so that, when trouble occurs among them, it is only necessary to raise a laugh against the leader of the disturbance, when he will cover his face and disappear from the scene. Mr. James had difficulty in getting his Somauli escort to submit to anything in the way of a leader. They rebelled when he undertook to put head-men over the guard-squads; and only the sense of a common danger when they got into strange parts, and a threat to expel troublesome persons from the camp, would keep them in order.

Earthquakes in China.—Dr. MacGowan, in connection with a record he has made of fifteen very perceptible earthquakes that were observed in China last year, remarked that three classes of seismic phenomena are distinguishable in that country, an insular, a littoral, and an inland class. Formosa and Hainan are both centers of seismic actions which often affect the mainland; and a considerable agitation of the sea has been observed in many cases of Formosan earthquakes. The Formosan earthquake of December 9th was the most violent one that foreigners so far have experienced; but the tall and slender pagoda-towers that adorn all Southeastern China, having stood for centuries unaffected by earth-waves, afford evidence that the shocks, though frequent, are harmless. Occasionally earthquakes of the littoral region are followed by the appearance on the ground of substances designated "white hairs" by the Chinese. When Dr. MacGowan first gave attention to them he thought they might be acicular crystals precipitated by gaseous action, but further research seems to indicate that they are not mineral but organic. Three foci for interior earthquakes may be indicated, two of which, Szechuen and Shansi, are very far from volcanoes, while shocks are often reported from them as continuous for considerable periods.

A New Hot-Water Cooking Apparatus.—Mr. Edward Atkinson has invented a new process and a new apparatus for cooking, which he gives to the public. The apparatus is operated by the heat derived from a common kerosene-lamp or from a gas-burner. The theory of it is based upon the non-conducting properties of certain materials with which the oven may be jacketed or incased. The inventor prefers pine-wood, which he forms into a box having walls from one and a half to three inches thick, according to the time during which heat is to be maintained within it. This is lined with metal, to make it water-tight. From one side or end of the box is projected a metallic tube, starting from near the bottom, bent so as to form a rectangle, and returning into the box near the top. This serves the same purpose as the pipes affixed to the water-back of a range. Inside the lined box is put as much water as is needed, and in this are inserted the cooking-vessel or vessels, of whatever material, which may or may not fill the box, provided about half an inch of water is left between them and the metallic lining of it. The whole is provided with a safety-valve or open way, to let off steam if the water should boil. The box and its contents, including articles to be cooked, having been arranged, the heat of a kerosene-lamp or gas-burner is applied to the projecting pipe, whence the heat is transmitted to the water inside of the box. A variation in the construction of the box is to have double-walled linings, with a space of about half an inch between the walls, through which the hot water may circulate. These metallic

walls are jacketed with asbestine or a mortar made of diatomaceous earth—"fossil meal,"—and then incased in wood; but the process of cooking goes on more slowly in this apparatus than in the one previously described. By throwing a woolen covering over the apparatus as soon as the cooking is done, the food may be kept hot for a considerable time. As no evaporation takes place within the apparatus, the cooked food comes out of about the same consistency as it went in. Allowance must be made for this fact in the preparation of the dishes. Though all of his apparatus has been crude and his efforts mostly tentative, Mr. Atkinson has had excellent success with most of the dishes he has cooked in it. They came out as well cooked as in other apparatus, except that they are never browned. He believes that his invention is susceptible of great improvement and development. He invites suggestions looking to those ends, but desires that all improvements belong to the public, and that the use of his apparatus be not encumbered by any patents. The date of his communication to us is April 9, 1886. The name of "The Aladdin" has been given to the invention.

Oriental Carpets.—The art of weaving—applied first to goods for clothing and to hangings and curtains for the tents of the pastoral people—has existed in the East from the earliest times. The designs now used, it is supposed by Mr. Vincent J. Robinson—an enthusiast on the subject of Oriental design—in a lecture on the subject before the British Society of Arts, are the same as were in use in the time of Abraham, and probably for centuries before. A representation of weaving, in a tomb at Beni Hassan, Egypt, which is as old at least as Abraham's time, shows two figures at work at a loom precisely like those now in use all over the East. Peculiar and distinguishing patterns marked the work of each tribe, and it is still often possible for the expert to determine by these patterns the district whence particular carpets have originated. Floor-coverings are pictorially indicated in the pavements of the palace at Nineveh, where the design of the carpet, marked by an inlaying of colored tesseræ, became a part of the permanent pavement. These designs are the same as those of some of the carpets still in use in Syria. Babylon was an important center of carpet-manufacturing; but, after the Roman conquest of Persia, all the goods of the region took the name of Persian, and it has lasted. The history of carpets in India can not be traced so far back, because of the obscurity of the sources and references; but there is reason to believe that, two or even three thousand years ago, the Indians had attained a higher state of refinement than they now possess. While sheep producing qualities of wool other than the finest abound in various parts of India, the very finest wool, called *put*, is only to be found in Turkistan, in the undergrowth which appears in the cold season. The fleece is shorn and the *put* is combed from the under part of it. This wool is used in the Cashmere shawls. Wool of similar quality is grown in Afghanistan and Khorassan, and about Shiraz and Kerman and Herat, at mountain-heights ranging from 4,500 to 7,600 feet. Besides these wools, camel's and goat's hair and the hair of the yak and the ibex are employed in carpet-manufacture. The finest of these is the *peshur*, or hair that grows close to the body of the goat, which is procured chiefly in the mountains of Afghanistan. Silk is occasionally used in Southern India, and gives an exceedingly lustrous effect to the pile. A carpet in the Vincent Robinson Collection, made entirely of silk, and probably of the sixteenth century, is wonderful as a mere piece of weaving, having four hundred stitches to the square inch. The old carpets were colored—red, with kermes or madder; yellow, with the pomegranate; and blue, with indigo. The manipulation of the manufacture consists in knotting with a double twist the wool forming the pile of the carpet firmly upon the foundation. The workman sits near the ground, with his legs in a hole in front of his work, which is wound upon a roller as it is done. A workman can make five or six inches by eighteen of the coarser kinds, less of the finer kinds, per day. Mr. Robinson is greatly impressed with the seemingly unconscious and special artistic gifts of the carpet-makers, and ascribes much of their success to their abhorrence of novelty. Indeed, he would like to make it an axiom that in fine design novelty

must be excluded. The real carpet-industry of the East is threatened with ruin from the competition of inferior English prison-work and the introduction of modern so-called improvements; and the modern Smyrna carpets have so degenerated "as even, in England, not to be accounted ornamental."

Life-History of American Snails.—Snails, according to Mr. Binney's monograph on "American Land-Shells," live in the forest, passing the greater part of their lives sheltered under the trunks of fallen trees, layers of decaying leaves, or stones, or in the soil. In the early days of spring they come out in companies, to sun themselves, and—possibly—to make love. Their eggs, which are laid when the weather has become favorable, are deposited in bunches of from thirty to fifty or more, slightly stuck together without any order, under the shelter of the leaves, or at the sides of logs and stones, generally at as great a depth beneath the surface as the animal can reach, and are then abandoned. This act is repeated two or three times during the season. The embryo can be seen within the egg in two or three days after it is laid, and emerges in the course of from twenty to thirty days, according to the weather. The young animal gnaws its way out of the egg, and makes its first meal out of the shell it has just left, and is then a snail of about a whorl and a half. But it grows very fast. It begins to prepare for hibernation at about the first frost, by ceasing to feed, becoming inactive, and fixing itself to the under surface of the substance by which it is sheltered, or burrowing a little way into the soil. The aperture of the shell looks upward, and the snail closes it by forming a glutinous shell-substance over it which is called the epiphragm. In this condition it reposes till spring. It also forms an epiphragm when it is in danger of being dried up in long droughts. Snails dislike to expose themselves to the sun, and are most lively on damp and dark days and at night. The American species are for the most part solitary, and in this respect differ greatly from their European congeners, which are social. Those, however, which have been introduced from Europe—and they are not few—retain their native habits. The appendages which perform the office of teeth for snails are peculiar in structure and various in form, and they do good execution on whatever eatables the animals may attack. The slugs are snails without external shells; are more nocturnal in their habits than the other snails; and are seldom visible in the daytime, though there may be thousands of them around. They do not hibernate, although they are partially torpid in cold weather. They have the faculty of suspending themselves in the air by means of a thread which they spin from a mucus secreted within their bodies. They have also the power of secreting at any point, or over the whole surface of their bodies, a more viscid and tenacious mucus, having the consistence of milk and nearly the same color—which constitutes a fairly valid armor of defense for them. It protects them against irritating substances, against corrosive gases, water, alcohol, and heat. They leave a trace of their usual secretion on every object over which they pass. This secretion appears to be necessary to their existence, for death follows the failure of the power to form it. All the species are exceedingly voracious, and feed upon plants and dead animal matter. Living creatures are too quick for them. They do much damage in the night and then retire to their hiding-places, leaving the gardener to wonder in the morning what destroying monster has been working among his plants.

Autobiography of an Ancient Cyclone.—Mr. John T. Campbell, of Rockville, Indiana, has described in the "American Naturalist" his tracing, by means of "tree-graves," of the course of a cyclone which passed more than three hundred years ago. The date of the storm was marked by noting the age of an oak which had grown on the top of one of the "tree-graves" or mounds. Its course was found by inquiring where other "tree-graves" had existed or had been observed in the past, and was traced in a belt about a thousand feet wide for fifteen miles. The "tree-graves," as Mr. Campbell calls them, are the marks that indicate where trees have been blown over, and consist of a depression formed by the pulling up of

the ground by the roots of the tree, and a mound on the side of the pit toward which the tree fell, formed of the earth which was thus pulled up. They are commonly called "Indian graves" by the people, and are supposed to be spots where Indian burials have taken place. Where they are numerous, as in the path of Mr. Campbell's cyclone, they are supposed to mark the place where a fierce battle has occurred. In the wild forest these marks are, though more than three hundred years old, as well preserved and as distinct in outline as many made by trees that have fallen recently. But if the land is cleared and cultivated they disappear in a very few years under the action of the plow and of exposure to frost and rains. The preservation of the little mounds in the woods, which under the continuance of the conditions might last for five thousand or even ten thousand years, is due to the thin coating of forest leaves that lies upon them. "The leaves act as shingles in shedding the rains, so that they are not washed or worn down by the falling rain or melting snow. The frost does not penetrate through a good coating of leaves, and therefore they are not expanded and spread out by freezing and thawing. I can see a great difference between the mounds in the wild forest and those on land that has been set to grass and pastured a few years. The tramping of stock, and the frequent expansions from freezing, which the grass does not prevent, flatten them perceptibly. The grass, however, does preserve them against rain-washings."

Fossil Fish in New Jersey Trias.—The triassic shales beneath the overflow of the trap-rocks of the Palisades of the west shore of the Hudson River have frequently been searched for fossils, but little besides dim tracings has yet been found in them. Mr. L. P. Gratacap says, however, in a communication to the "American Naturalist," that Mr. F. Braun, of Weehawken, New Jersey, has lately found a number of fish remains in these slates, of which he has extracted specimens of considerable beauty, together with vegetable fossils. Among the remains are casts and impressions of plant-roots or root-like fragments, the lobate divisions of an aquatic plant, an enigmatical nut displaying its coaly and black nucleus, and numerous fishes in various stages of preservation, and in positions that seem to throw a light upon the local circumstances of their entombment. The fishes are apparently identical with *Palæoniscus latus*. In the sandstones below these shales, Mr. Braun has found tracks, ripple-marks, and rain-fossæ.

NOTES.

Emma H. Adams, in an account of "Salmon-Canning in Oregon" which is published in the Bulletin of the United States Fish Commission, says: "In the four large houses I visited, Chinamen were doing all the work of canning, under an American superintendent; and I believe every firm employs them. The process, consisting of not less than a dozen or fifteen different steps, requires at some stages great skill and celerity. For such work the lithe Celestial is well adapted. He is attentive, exact, prompt, faithful, and silent. Garrulous as a parrot with his countrymen usually, he is speechless if set to precise tasks, especially where his wages are to be proportioned to the amount of labor he performs."

The war against the phylloxera in France has been waged with wonderful vigor, and has resulted so far in redeeming more than half of the infected country from the attacks of the pest. The methods of fighting employed are first, submersion of the whole land until the invaders are drowned—the most effective method, but applicable only to low lands; second, carbon bisulphide, which kills by direct contact and by its vapor; and third, potassium sulpho-carbonate. In 1885 submersion was applied to 24,339 hectares; carbon bisulphide to 40,585 hectares; and the sulpho-carbonate to 5,227 hectares. Professor W. Mattieu Williams remarks on the way the French farmers have barred this visitation and succeeded in staying it, that it affords a clinching proof of the success of the system of peasant proprietorship, which has converted every rustic, even the very poorest, into a capitalist with a sufficient reserve to battle against such a calamity.

Fixed color-standards are in demand for anthropological purposes. Those which were issued by Broca several years ago show a tendency to fade. Mr. Galton, looking about him for something more durable, has decided upon the imperishable enamel which is employed for Roman mosaic-work, and has recently visited the Vatican manufactory for the purpose of obtaining typical colors among its products.

Dr. W. F. Morgan, of Leavenworth, Kansas, communicates to the "Medical Record" a story which would indicate that swallows have considerable surgical skill as well as intelligence. In a nest he found a young swallow much weaker than its mate, which had one of its legs bandaged with horse-hairs. Taking the hairs away, he found that the bird's leg was broken. The next time he visited the nest, he found the leg again bandaged. He continued to observe "the case," and in two weeks found that the bird was cautiously removing the hairs, a few each day. The cure was entirely successful.

Professor Robert von Helmholtz has published in Widermann's "Annalen" the final results of the experiments and arguments on the formation of mist. The air must contain a normal quantity of solid particles of dust, and must be free from bodies that will act chemically on aqueous vapor.

The Himmelbjerg, or Heaven Mountain, has until recently enjoyed the distinction of being the highest mountain in Denmark. It is four hundred and eighty-two feet high. It has now to yield the palm to two peaks recently measured in the forest of Ky, the highest of which is five hundred and thirty-two feet above the sea. These mountains have not been named; and it would indeed be hard to find a suitable name for a mountain overtopping the "Heaven-peak."

The fact has recently been confirmed by a number of observers that the electric eel can exert its power through the water to a distance. Professor W. Mattieu Williams relates that he once plunged both hands into water containing one of these fish, intending to grasp it, but failed to reach it; but he received a very severe shock when at some distance, probably three or four inches, "the sensational nature of the experiment rendering any approach to accurate estimation of the distance quite impossible."

The bascule is a new instrument for recreation, which has been developed out of the primitive see-saw by Mr. Piercy, of Birmingham, England. His first specimen was constructed for his own family. The bascule consists of a wooden beam, which is supported on a four-legged iron stand. The seats are so arranged as to remain always horizontal, whatever the position of the beam may be, while the adjustment for players of unequal weight is effected by a balancing block, which is slid along the beam till it reaches the point where it is wanted, and is there locked in position by the act of loosing the handle. The bascule has also a horizontal movement, and can be used as a merry-go-round.

A story of two sagacious crows is told in "Land and Water" by the Rev. F. O. Morris, on the authority of a land-owner of Loch Orr, who saw the birds annoying two hares. Although he could not see clearly, on account of the high grass, he was sure the hares had young ones, which the crows were trying to carry off. After the hares had fought the birds for some time, one of the "black robbers" managed to attract their attention, and led them off a little, while his confederate flew round and seized a small animal, which screamed loudly, when both birds flew away. He was satisfied that their purpose had been to get one of the young ones of the hares, and that they had succeeded.

Sir William Thomson has described a new form of spring-balance for the measurement of terrestrial gravity. One end of the spring is fastened, while the other end is weighted sufficiently to keep the spring straight when horizontally fixed. The spring is adjusted within a brass tube on a slope of about one inch in five, in which position it is in nearly unstable equilibrium. The observation consists in marking the number of turns of the micrometer series attached to the spring which are required to bring the weight from the balanced to the horizontal position. The instrument is sensitive to a forty-thousandth of the force of gravity, and to differences of temperature of $\frac{7}{20}$° C.

It is proposed to erect a monument to the memory of Thomas Edward, the Scotch naturalist whose death we have recently noticed. A committee has been formed, under the auspices of the town authorities and the scientific and literary clubs of Banff for the furtherance of this object, and invites subscriptions.

M. Chevreul, who attended the meeting of the French Academy of Sciences on the 17th of May, was there presented, in anticipation of his attaining a hundred years of age in August, with a bronze bust of himself, executed by M. Paul Dubois. The presentation was made at that time instead of waiting till the coming of M. Chevreul's birthday, on account of the approach of the summer vacation, which would take many of the members of the Academy away from Paris.

Herr Familiant, of Berne, has been studying the brain of a lioness, and finds that in form it is nearly intermediate between that of the dog and that of the cat. It is distinguished from both by relatively small projection of the cerebellum and narrowness of the *lobus pyriformis*. Further, the chief fissures of the brain of carnivoras are also to be found, with minor differences, in that of primates.

Professor A. Vogel has observed that plants do not always contain their characteristic alkaloids when grown under other than natural conditions. Hemlock does not yield conine in Scotland, and cinchona-plants are nearly free from quinine when grown in hothouses. Tannin is found in the greatest quantity in trees which have had a full supply of direct sunlight.

The severe weather of the early days of March in parts of England was very fatal to birds of the thrush tribe, many of which died from starvation and weakness. A total change of scene followed the turn of weather to warm, and the bird-life became one of general vigor and activity, with mating and singing, and nest-building constantly going on.

Dr. C. Blarez says that the materials used for coloring wine, such as sulpho-fuchsine, are capable of setting up a great deal of gastric disturbance in persons having weak digestion.

Werkhojanck, in Siberia, latitude 67½° north, still maintains its position as the coldest place on the earth. A Russian Government surveying expedition reporting to the Academy of Sciences of St. Petersburg, concerning its temperature observations there in 1885, gives the mean temperature of the year as 17° C., or 1° Fahr., the mean temperature of January of that year as —49° C., or — 56° Fahr., and the minimum for the same month as — 68° C., or — 90° Fahr.

OBITUARY NOTES.

M. Jules Célestin Jamin, one of the most eminent French physicists, died in Paris on the 12th of February. He was born in 1818, and spent most of his active life in scientific professorships. He was intrusted by Minister Duruy with the duty of opening the public lectures of the Sorbonne. He was made a member of the Physical Section of the Academy of Sciences in 1868, and was elected perpetual secretary, succeeding Dumas, in 1884. His most important scientific labors were in the field of optics. He also made investigations in capillarity, devised a new method of preparing magnets, introduced modifications into the Jablochkoff system of electric lighting, and at a later period devoted his attention to the hygrometer.

Professor Heinrich Fischer, of the University of Freiburg in Baden, who died last February, was a diligent student of microscopic mineralogy, and distinguished himself by his investigations on the origin and character of jade, concerning which he published, in 1875, the book "Nephrite and Jade."

Mrs. Erminnie A. Smith, who was a student of American anthropology of growing fame, died at her home in Jersey City, New Jersey, June 9th. She was born at Marcellus, New York, in 1838, and was taught in Mrs. Willard's Seminary at Troy. As President of the Jersey City Æsthetic Society, which she formed in 1876, it was her privilege to entertain many literary persons. In 1880 she was engaged by the Smithsonian Institution to investigate the folk-lore of the Iroquois Indians, and went among them, becoming a member of the tribe. At the time of her death she was employed in preparing a dictionary of the Iroquois language. She was a member of Sorosis, the New York Historical Society, the New York Academy of Sciences, and the London Scientific Society.

Dr. Julius Adolph Stöckhardt, the eminent chemist, died at Tharandt, in Saxony, June 1st, in his seventy-seventh year. He was best known by the services he rendered to agricultural chemistry. He was the originator of the system of agricultural experiment stations now become so general, and was for many years director of the establishment of that character at Tharandt. He was successively editor of the "Polytechnisches Centralblatt," the "Zeitschrift für deutsche Landwirthe," and "Der chemische Ackersmann," and aided in the establishment of the journal "Die Landwirthschaften - Versuchs - Stationen." His writings were usually intended to make chemistry intelligible to lay minds; and one of them, translated and published as "Stöckhardt's Principles of Chemistry," has found much favor in this country as a text-book. A sketch by Professor Atwater and portrait of Professor Stöckhardt were given in the "Monthly" for June, 1881.

Dr. E. Linnemann, Professor of Chemistry at Prague, died April 27th. He had prepared a communication, which was found among his papers, announcing the discovery, in the orthite of Arendal, of a new metallic element, which he called Austrium. M. Lecocq de Boisbaudran has, however, suggested that this metal is probably gallium, of which orthite contains a small quantity.

A. Von Lasaulx, Professor of Mineralogy in the University of Bonn, who died in January last, was one of the most active of German workers in mineralogy and petrology. He was forty-six years old.

Dr. Charles Upham Shepard, formerly of Amherst College and the South Carolina Medical College, died in Charleston, S. C., May 1st. He was the owner of extensive collections in mineralogy, which he gave to Amherst College a few years ago.

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EX-PRESIDENT PORTER ON EVOLUTION.*

By W. D. LE SUEUR, B. A.

THE great intellectual issue of the present day, however some may try to disguise it, is that between dogma on the one hand and the free spirit of scientific inquiry on the other. In using the word dogma, we have no wish to employ the argument *ad invidiam*—to take advantage, that is to say, of the popular prejudice no doubt attaching to recognized *dogmatism*. No, we frankly confess at the outset that a man may argue for dogma without betraying any dogmatic spirit; and that there would therefore be no fairness in embracing dogma and dogmatism in a common condemnation. None the less do we maintain that dogma is opposed to the free scientific spirit; and that the world is now being summoned to decide which of the two it will take for its guide. A definition of dogma, as we understand it, is therefore in order. By dogma we mean a traditional opinion held and defended on account of its assumed practical value, rather than on account of its truth—an opinion that is felt to require defending; that, like our "infant industries," needs protection; and round which its supporters rally accordingly. When great and special efforts are being made to place and keep a certain opinion on its legs, so to speak, be sure that it is a dogma that is concerned, and not any product of the free intellectual activity of mankind.

The last writer of eminence who has "come up to the help of the Lord against the mighty," or, in other words, to the help of orthodoxy against evolution, is Dr. Noah Porter, ex-President of Yale. Dr. Porter is a man who has lived for many years in an atmosphere of philosophical discussion, as well as of high literary cultivation; and

* Evolution. A Lecture read before the Nineteenth Century Club, May 25, 1886. By Noah Porter, D. D., LL. D., ex-President of Yale College. Herbert L. Bridgman, 55 Park Place, New York. 1886. Pp. 33.

we could perhaps scarcely name an American whom the common voice would pronounce better fitted to grapple with every phase of the doctrine of evolution in a logical and scholarly manner. We must confess, however, to a certain amount of disappointment with both the matter and the manner of the learned ex-president's "Lecture on Evolution," delivered before the Nineteenth Century Club, on the 25th of May last, and now reprinted for general circulation in pamphlet form. Our objections to the *matter* will appear as we proceed: our objection to the *manner* is that the learned ex-president has really not been so careful as he should have been—as one would suppose he would, almost by instinct, be—to clothe his thoughts in correct literary, or, let us say at once, grammatical form. One does not like to discuss questions of grammar in connection with a discussion of evolution; but, really, there is ground for complaint when a writer of the high competence of Dr. Porter embarrasses and irritates the reader of his lecture by simple inattention to the rules of composition.

The reader is not left long in doubt as to Dr. Porter's point of view. He says, in effect, at the outset, that the question of evolution might be left for scientists and philosophers to settle between them were it not for the fact that, as frequently presented, it involves consequences to Christian theism and natural ethics: this fact renders the intervention of the theologian necessary. Here we see the issue plainly formulated between dogma on the one hand and the free conclusions of the human intellect on the other. The theologian must intervene—why? What does he know of the matter in hand that "scientists and philosophers" may not equally know? Why should the interests of truth be dearer to him than to them? It will scarcely be pretended that the special knowledge of doctrinal systems in their succession and relation, or of the textual criticism of the Scriptures, which a professed theological student might be supposed to possess, would be of any great service in a discussion of the Darwinian theory or of the larger aspects of biological evolution. Yet, unless the theologian intervenes by virtue either of such special knowledge or of some special authority of a sacerdotal kind with which he claims to be invested, we fail to see how he can be said to intervene *as a theologian* at all. If he simply joins in the discussion on general grounds, contributing his quota of information or of logical discrimination, as any one else might do, why, then, he merely sits down with the "scientists and philosophers"; and happy is he if he can hold his own in such good company. Now, the truth is, that the learned doctor's intervention has been precisely of this kind. We fail to discover that he has uttered a single word in his character as a theologian, or done the least thing to show that evolution can not be safely and thoroughly discussed on grounds of science and philosophy. The only significant thing about his intervention is the *animus*. He thought he could deal with the matter as a theologian and he wished to do so. His

feeling at the outset doubtless was, and perhaps still is, that science and philosophy *ought* to be amenable to some higher control; but he has totally failed to show that such is the case. He finds that only by talking the language of science can he come into contact with science; and so with philosophy; and that there is no higher bar than their own before which these can be summoned. The result is instructive for all who lean to the opinion that Theology is still queen of the sciences, and that her writ runs through the whole domain of human knowledge. The return made to that writ in the most flourishing portions of the intellectual world to-day is: "No jurisdiction! Come down to facts!"

The ex-President of Yale is not opposed, he tells us, to evolution in every aspect: "Evolution or development, in their [*sic*] noblest and fullest signification, may spiritualize nature, ennoble man, and honor God. The evolution which we criticise is a composite of scientific theories—some true, others doubtful, and others false—which are held together and wrought into a fanciful philosophy by the very slenderest threads of analogy, and elevated into a negative theology by a daring flight of professedly modest or agnostic reserve." Recognizing that this "fanciful philosophy" is made up of several distinct elements, the critic announces that he will take up these in the order of their production and show their genetic connection. To our great surprise, after reading this declaration, we find that the following is the order in which the "elements" in question are placed:

1. Darwinism, as applied to contemporary species.
2. The same extended into the region of paleontology.
3. The arguments drawn from biological study.
4. The doctrine of the conservation of force.
5. The doctrine of the development of the organic from the inorganic.
6. The extension of No. 5 so as to include the phenomena of sensibility among the developed products.
7. Its further extension so as to include the sense of personality.
8. The arguments drawn from the development of language and of human society.
9. The wider theory of cosmical development as suggested by the nebular hypothesis.
10. A materialistic interpretation of the universe.
11. Agnosticism.

How it could occur to Dr. Porter that this arrangement represents in any degree "the order of time and thought after which they" (i.e., the several elements of the prevailing evolution philosophy) "have successively come into form or being," we can not imagine. There is really not the least vestige of an historical order discernible. Instead of Darwinism being put first, it ought rather to have been put last. It was the apparent immutability of species that for a long time stood

in the way of the adoption of a general theory of development, which the labors of many men in different fields had been preparing. The ship was on the stays, prepared to glide into the ocean, when Darwin came and knocked away one or two of the blocks that had been most obstinately hindering her descent. The wonderful success of the Darwinian theory was chiefly due to this very circumstance, that so much had been already done to facilitate its acceptance. The doctrine of the correlation of force, to which Dr. Porter assigns the fourth place, was, if we date it only from the publication of Grove's treatise, seventeen years old when the "Origin of Species" appeared. The nebular hypothesis had been waiting for over a hundred years, or since the publication of Kant's "General History of Nature and Theory of the Heavens." The progress of society and perfectibility of human nature were the commonplaces of the last century, which was also thoroughly familiar with the discussion as to spontaneous generation, or the development of the organic from the inorganic. Why the arguments from biology should be separated from Darwinism proper it is difficult to see, considering that Darwin, from the first, based his theory of the origin of species on biological grounds, quite as distinctly as on the operation of the struggle for existence. It is Darwin, above all men, who has popularized the arguments from rudimentary organs and from the changing phases of embryonic life. Could Dr. Porter have made good his promise to describe to us the evolution of evolution, if we may so express it, he would have done a very useful work; but the fact is, he has not even attempted it, but has simply given us what, if we may be allowed for once to adopt a common misquotation of Horace, may very truly be called the *disjecta membra* of a philosophy.

Leaving this point, however, let us inquire what the author of the "Lecture on Evolution" has to say on the several heads into which he has divided the subject. In regard to "Darwinism," he finds the evidence for the transformation of species insufficient. He admits the tendency to variation and the struggle for existence; but does not see that these, alone or principally, determine the origin of species. One may go a long way with Darwin, he says, and yet fail to draw the conclusion that three or four original types have been the ancestors of all other organic forms past and present. This language is dubious. It might suggest that, had Darwin been a little more liberal with his archetypes, the learned doctor would have agreed with him fully. What is it "to go a long way with Darwin"? The mere recognition of the tendency to variation and the struggle for existence is not to *go* with Darwin at all: it is merely to accept his starting-point, and to recognize facts that were fully recognized long before his time. It is a pity that so doughty a champion of orthodoxy as Dr. Porter does not tell us more distinctly what his own position is. Apparently he rejects the theory of transformation by change of environ-

ment. Does he, then, believe in the theory of special creation? Was there no "becoming" for the forms we see? Were they suddenly flashed into existence by the Divine fiat, or did they struggle out of the ground like Milton's horse? There is little gained, from the strictly orthodox point of view, in holding aloof from Darwin's conclusion, on the simple ground of the insufficiency of the evidence, if you hold yourself prepared to accept it as soon as a little more evidence is tendered. If the theologian descends into the arena, it should be, not to declare that the Darwinian hypothesis is as yet unproved—a simple man of science, if he thought the facts warranted it, might do that—but to declare it, on *a priori* grounds, unprovable because false. When Theology can take this tone and make it good, she will be listened to; but, when theologians merely potter in science, there is really no special significance in their acceptance of this or their rejection of that scrap of scientific doctrine; what their opinion, one way or another, is worth, simply depends on the degree of their competency in relation to the matter under discussion. This is a point that should not be lost sight of; for a certain illusion is apt to be created when a professed theologian enters the scientific arena. He is popularly supposed to carry with him certain higher canons of criticism, to represent some authority that can traverse the decisions of science and hold them in check. It is important, therefore, to watch him and see what he does; and if we observe that he is merely making what use he can of his knowledge of the scientific elements of the case, and carefully keeping his theological commission in his pocket, we should attach no more importance to his intervention than if some scientific student or literary man of about equal knowledge of the subject had come forward to have his say.

In favor of Darwinism there is this to be said, that it deals with *veræ causæ*. It points to certain natural laws or conditions that visibly tend toward the variation of species, and it furnishes, in certain cases, almost conclusive evidence of the descent of different types from a common ancestral form. What, it may be asked, has theology done to render the world of organic forms intelligible to us? All the talk we now hear about a plan of creation and divine ideals is simply an attempt to give a theological complexion to facts that science has discovered, and that are found to be incongruous with the rude conception of creation hitherto current. In company with Darwin and Spencer we feel that we are at least on the road to sound and exact knowledge of the processes of development, to an understanding of how what is came to be as it is. In company with the theologian we quickly realize the hollow and formal character of the explanations he tenders. Except when he openly borrows the language and theories of science, he has absolutely nothing to tell us that our intellectual faculties can appropriate. If theology had a theory of the universe capable of entering into serious competition with the theory of evolution, then no doubt

the weakening of the latter might mean the (relative) strengthening of the former. But such is not the case: the theologian, as a theologian, can only say, "God made the world"; science alone can undertake to show how the work was accomplished, i. e., through what successive stages and genetic connections. If, then, the evidence for Darwinism, or for evolution generally, is not complete, all we can do is to wait until it is complete, or until *some* physical theory of things is established on solid grounds of evidence.

Not only is Dr. Porter himself persuaded that there is no conclusive evidence for the Darwinian theory; but he asserts that "the practical common sense of mankind and the sagacious tact of most naturalists has [*sic*] usually decided . . . that under the present conditions or laws of being, within the historic period, the limits of well-defined species have not been and are not likely to be changed." Evidently "the common sense of mankind and the sagacious tact of most naturalists" are very much on their guard. They don't want to decide anything rashly, so in delivering their opinion they stipulate for "present conditions" and "well-defined species" and "the historic period." Where they momentarily forget themselves is where they seem to stretch the historic period into the future, asserting that within the limits of that period "well-defined species are not likely to be changed." This is undoubtedly a slip on the part of the "common sense" and the "sagacious tact"; for a period can not be "historic" until it has had a history.

It is needless to say that Dr. Porter's opinion as to the unsatisfactory nature of the evidence for Darwinism is not conclusive. As he has appealed to the "sagacious tact of most naturalists," let us see what a naturalist and biologist of the highest order, the Rev. W. H. Dallinger, F. R. S., has to say on the question at issue in the very last number of the "Contemporary Review." These are the learned gentleman's words:

"The philosophical interpretation of modern biological knowledge which originated in Darwin, and has been universally received by trained and competent students, stands so securely that there is little need of additional facts to make it, so far as it is intended to reach, an immutable element, in all future time, in the interpretation of vital phenomena. Much may be added, but the philosophy of the 'Origin of Species' must remain. It is, however, a matter of the deepest interest and of much moment that the active investigations carried on by biologists all over the globe, not only give an unbroken stream of evidence coincident with the great law of variation and the survival of the fittest, but that, ever and again, facts of the largest import present themselves, that pour a flood of light, as unexpected as it is confirmatory, on this great biological law. It was a discovery of much philosophical value and biological interest, that the duck-bill and echidna were oviparous though mammals; this was a final confirma-

tion of what was before partially learned from their osteology and the little that was known of their embryological features, viz., that there must have been a root-stock out of which, in an unmeasured past, arose both the reptilia and the earliest mammals. But a new fact of even larger interest and carrying us inconceivably further back, taking us indeed, with something like clear light, to the origin of the vertebrates themselves, is presented to us by Mr. W. Baldwin Spencer, of the University Museum, Oxford. Mr. Spencer only presents the facts, but their bearing on the philosophy of evolution is apparently inevitable; and certainly they are inexplicable save by this hypothesis."

Then follows an account, for which we have not space, of the discovery, imbedded in the skull of a vertebrate animal, of an *invertebrate eye*—an atrophied organ, devoid of all function, but pointing to the conclusion, in Dr. Dallinger's words, "that the tunicates and the vertebrates arose in one stock of enormous antiquity." The above extract, however, is chiefly significant for the emphasis with which it asserts the dominion that the Darwinian philosophy has acquired over the minds of competent students of science, and the extent to which it is inspiring and directing their labors. In the face of such powerful testimony, how petty seems the quibble about "the sagacious tact of most naturalists" having decided that "within the historic period" the limits of "well-defined species" have not been changed! Whatever most naturalists may think on this altogether secondary point, it is abundantly evident that they accept the Darwinian theory as a whole, and make it a guiding light in biological research. Any one who wishes to see in what esteem Darwinism is held among men who occupy themselves with the study of organic nature need only turn to the proceedings of learned societies, and he will there see that Darwinism, or, as Dr. Dallinger happily expresses it, "the philosophy of the 'Origin of Species,'" is almost universally accepted as the starting-point of biological speculation. Its general principles will be found to be either tacitly assumed or expressly acknowledged, in nearly every contribution made to those sciences on which it has any bearing. How wide is the range of its application may partly be judged from the following summary, taken from "Nature" of October 23, 1884, of an essay read by Dr. Kirchhoff, of Halle, at the Magdeburg meeting of the Association of German Naturalists and Physicians, on the subject of "Darwinism and Racial Evolution":

"It was argued that the physical development of peoples was intimately dependent on the natural conditions of their respective surroundings. The inhabitants of northern lands are noted for a preponderance of the pulmonary functions; those of hot, moist, tropical regions for a more marked activity of the liver. Thus, the strongest lungs prevail among the Mexicans, Peruvians, and Thibetans, who occupy the three highest plateaus on the surface of the globe. . . . The daily pursuits of a people are constantly evoking special organic

peculiarities. This is shown most clearly in the keen sense of smell, sight, and hearing, observed in all hunting and pastoral tribes of the highlands and steppe-lands, as well as in the sense of locality and the surprising physical endurance under hunger, thirst, and other privations. . . . The principle of selection prevails in the moral as well as in the physical order. As mankind pressed northward, irrepressible spirits alone could sustain life under the depressing influences of bleak Arctic surroundings. Hence the remarkably cheerful temperament of the Esquimaux, who are also bred to peaceful habits ; for peacefully disposed families alone could dwell under a common roof, as the Esquimaux are fain to do in the total absence of fuel. Through over-population the Chinese have become the most frugal and industrious of peoples, in recent times emigrating to foreign lands and crowding out all more indolent or pretentious races."

These are but a few examples of the changes which environment can work, in periods of time by no means unlimited. Yet Dr. Porter forbids us to believe that a changing environment, operating through periods of indefinite length, has wrought *specific* differences. What we *know* is that in past ages thousands of species have died out and given place to others ; and the only question to be settled is whether the connection between successive forms was a genetic one or not. We can conceive the Creator as wiping the slate, so to speak, of his organic creation, and then covering it again with new forms more or less like the former, but having absolutely no connection with them, and as repeating this operation unnumbered times. The trouble with that conception is that it is a little too barren. It might serve for a postulate in theology, but there is no nourishment in it for the human mind. It dispenses with all cause save a formal and hypothetical one ; it takes all meaning out of the universe. The world therefore prefers to believe with Darwin that the stream of life has been continuous, and that all existing forms of life have truly issued from those that preceded them ; and the world is thankful to Darwin for having done something—nay, much—to show how the transitions from form to form may have been accomplished. He may not have solved the problem entirely—it is not pretended that he has ; but thoughtful people in general feel more disposed to make the most of the indications he has furnished than to carp at the evidence as not being logically complete.

According to the learned critic, it is owing to a sense of the insufficiency of the evidence afforded by the paleontological record that the evolutionist resorts to the arguments from biology. Here comes in a remarkable bit of writing : "Perhaps it would be more fair to say, if he [the evolutionist] knew how to put his case in the strongest form, that he would urge that experimental proof is not to be looked for, but only indications of a peculiar character." This may be considered a perspicuous style of composition at Yale ; but we confess to

finding it uncommonly cloudy. We remember, of course, that our author is not bound to furnish us with brains as well as with arguments; but, using such brains as we have, we venture to suggest that the substantial meaning of the sentence might better have been expressed in the following words: "Perhaps, if he knew how to put his case in the strongest form, he would urge," etc. We might then with less distraction have admired the modesty which offers to assist the Huxleys and Spencers, the Morses and Fiskes, to state their case in the strongest form, and also the curious felicity of the adjective "peculiar" as applied to the "indications" which the evolutionist, duly instructed by the ex-president, would say are to be looked for. A sentence or two further on we come across what may fairly be styled a "peculiar indication," namely, the word "protean," used in the sense of "most primitive," in the phrase "from the protean forms up to the human." Haeckel and other naturalists talk of the *protista;* and Dr. Porter apparently thinks that "protean" is the proper cognate adjective.

The biologist, we are told, "makes much of the existence of rudimentary organs in the higher species of animals, *and* which [*sic*], he contends, give positive evidence of a great number of intermediate members or links in the great chain of progressive development, which have left no remnants or traces behind." Does the biologist really talk in this fashion? We very much doubt it. How can these "intermediate members" have left no remnants or traces behind, if they have left rudimentary organs as memorials of their existence? Then what is the force of the word "intermediate"? Intermediate between what? A rudimentary organ simply points to some *anterior* form, in which the organ was better developed. The word "intermediate" has here absolutely no application. Our author is able, however, to give us the philosophy of the rudiments. It "can not be denied," he says, "that they prove a unity of plan or of thought, of beauty and order, in the production of the wondrous cosmos of animal life, including a dramatic order in the introduction of its families and groups." When people say that a thing "can not be denied," they generally mean that it must be admitted. If Dr. Porter uses the words in this sense, he simply closes the whole case without further argument. The same method applied to the question of evolution at large would have saved him the trouble of writing his lecture; though possibly a brief oracular announcement might not have wrought instant conviction in the minds of the Nineteenth Century Club. We are going to be very bold, for our own part, and insist on treating the question as still open. We say then that, in our opinion, Dr. Porter's theory of "a unity of plan or of thought, of beauty and order," is not tenable, and that the evolution theory alone meets the case satisfactorily. There is no use in talking of beauty or order, unless we mean such beauty and order as human faculties can recognize. Now,

our human faculties do not recognize beauty in the useless and dwindling rudiments of once-developed members. We are profoundly interested in the invertebrate or molluscoid eye of the vertebrate, *Hatteria punctata*, referred to by Dr. Dallinger, an eye "so buried in its capsule and surrounding tissue, and so covered with the skin of the head, as to make it almost inconceivable that it can be affected by even the most intense light"; but, if we are asked to admire the beauty of the arrangement, if we are summoned to recognize a wonderful example of order in the perpetuation of so functionless a structure, we hold back. The main element in beauty is fitness, the main element in order is purpose; and we see neither fitness nor purpose here. The only conceivable *purpose* would be to guide the biologist to the very conclusion he has arrived at, namely, that a remote ancestor of Hatteria was a mollusk; but, although as worthy, perhaps, of a few providential arrangements in his favor as anybody else, the biologist is not prone to think that such helps as he finds on the way were designed for his special benefit. He does not very well see how a past order of things could help leaving traces of itself; and he rests in the facts as they are.

Rudimentary organs, Dr. Porter assures us, bring more difficulties than aids to the doctrine of evolution. This is an extraordinary statement, seeing that competent biologists, almost without exception, have taken a directly opposite view. Does the learned doctor mean to say that biologists in general are radically incompetent to interpret the facts with which they have to deal—that facts which they ought to regard as subversive of a theory, or at least as throwing serious difficulties in its way, they accept with one accord as confirmatory of it? There is manifestly only one remedy for this state of things, and that is that the biologists of Europe and America should go to school to the ex-President of Yale, and learn from him how to read the book of Nature. Possibly, in that case, one of his bright scholars might ask him how it was, if the facts in connection with rudimentary organs brought more difficulties than aids to the doctrine of evolution, that he had himself declared, *in the very same sentence in which that statement was made*, that, were the doctrine of evolution satisfactorily established on other grounds, the existence of rudimentary organs *would be consistent therewith.** Then, perhaps, the class might be broken up. The scholars would, perhaps, not wait to hear the master discourse on embryology, and show how the successive stages of em-

* Here is the sentence—a remarkable one: "That they [rudimentary organs] would be consistent with the doctrine of evolution by favoring and continued environment, provided this were established on other decisive grounds, is also true; but they bring more difficulties than aid to this theory, inasmuch as the critic asks at once, If the movement of evolution were so wide-spread and long-continued, why are not these broken links more numerous?"—(Lecture, p. 10.) We fail to see the propriety in calling rudimentary organs "broken links."

bryonic life may be interpreted as a kind of "logical growth" or the development of a plan. The difficulty with this interpretation, again, is that it is merely formal and means nothing. If a Divine plan is to be invoked on every occasion as the explanation of whatever is obscure, all rational inquiry is at an end. God is not bound to give reasons. His ways are past finding out. Nature's ways, on the other hand, do lend themselves to progressive interpretation. There are ultimate questions that always elude us, but we can learn through experience and observation to connect cause and effect, antecedent and consequent. It is upon this line that the scientific investigators of the day are working; and not a day passes without bearing witness to the fruitfulness of their methods. This is the reason why, among scientific workers, an hypothesis that lends itself to verification, that deals with the actual and real, is always preferred to one that supplies a formula and nothing more.

We pass over, as containing little or nothing that is relevant to the subject of evolution, Dr. Porter's discussion of the doctrine of the conservation of energy. The next section of the lecture deals with the theory that the phenomena of life may be highly specialized and complicated forms of mechanical (molecular) action. "To put forward such a theory," says Dr. Porter, "is to hypostatize an agency or an agent of the vaguest and most nebulous character, and to claim for it all the attributes of things or agents that are known to exist under the severest tests of observation and experiment." We wish Dr. Porter would explain how it is possible to hypostatize an agent of the most nebulous character and yet assign to it a most definite character. The theory under consideration simply proceeds upon the principle that to simplify or explain you must generalize—that is to say, you must find the means of expressing the special in terms of the general. The phenomena of life are highly special phenomena, and we are naturally led to wish to see them in wider relations. To rest in the special is to rest in nescience; and the awakened human mind does not consent to that. The widest relations of all are those which we call mechanical; the natural tendency of thought, therefore, is toward the belief that it is through the compounding and recompounding of these, in ways and regions at present far beyond our ken, that matter acquires its higher and more specialized functions. We see in the human body what a mere aggregation of cells may become; we see in human society what a mere aggregation of individuals may become; and it is impossible that Science should not seek her equilibrium in some theory of the essential unity of all forms of matter and all modes of force. We must, however, quote a powerful sentence which in the lecture before us immediately follows (page 15) the words last quoted: "To apply induction to a process which ought to begin with analogy and end with fact, but which begins with a surmise and ends with a dogma, is to reverse the order and to deny the criteria which have given Science

her authority to prove and Philosophy her power to prophesy." This has a most magisterial and academic sound; but oh! will somebody please to say what it means? The oracles of old were often of doubtful import; the trouble with them was that they admitted of too many interpretations. But the trouble with the oracle before us is that, to our finite comprehension, it does not admit of any interpretation. How can *induction* be applied to a *process?* Induction is itself a process. Again, how can the application of induction to a process (admitting the thing possible) constitute the reversal of an order? Should the process be applied to the induction instead? What, we fancy, Dr. Porter meant to say was, that a certain process, which he tries to describe, reverses the order and denies the criteria, etc., *not* that the application of induction to the process has that result. But who should be able to say what he means in clear and unmistakable language if not an ex-President of Yale? The fact is, however, to return to the main question, that the criteria of science are not denied, nor is "Philosophy" robbed of any power she ever had to prophesy, by the hypothesis under consideration, which is constructed, as we have tried to show, strictly in accordance with established analogies. There are just two courses open to us: one is to assume, with each advance in the complexity of phenomena, the introduction of some new force wholly unlike and unconnected with those manifested in simpler phenomena; the other is to assume that all force is one, and that it is merely the progressive compounding of the simplest relations that yields the successively higher functions and products. Men of science in general incline to the second alternative rather than to the first.

"In spite of our cautions," says Dr. Porter, "evolution will take another step upward, even though it plant its ladder in the clouds and lean it against the sky." How are we to explain such daring perversity on the part of "evolution"? Could it be that Dr. Porter's cautions are not understood? There are phrases and sentences in the pages before us which really suggest an excuse for evolution on this score. What, for example, does this mean: "The unfeigned gratitude in the presence of others, or their displeasure, is soon fixed in the brain reactions"? If we thought the context would throw any light on this remarkable utterance we would quote a certain amount of it; but we have carefully scrutinized it ourselves without getting any help. Dr. Porter is here assailing the evolutionary view of ethics, but that he adequately understands it is not very evident, in spite of the profuse use he makes of technical phrases. We find no reference in his argument to the development of social morality through domestic—to the origination of morality, according to Herbert Spencer, who is perhaps as authoritative an exponent of evolution as could be named, through the care for progeny. If Dr. Porter had really wished to do justice to this part of his subject, he should certainly have taken full account of the line of argument followed out in the "Data of Ethics."

He probably would not then have written the following awkward and pointless sentence: "The altruistic experiences which somehow find themselves within the arena of man's private experience naturally secure to themselves the response of man's interested gratitude; selfishness awakens a natural antipathy." Surely the word "experiences" here should be replaced by "sentiments." Imagine "experiences" securing a "response of interested gratitude"! Then, what is meant by qualifying gratitude as "interested"? We imagine that it is of the nature of gratitude to be interested. The main point is, however, that the evolution philosophy *does* explain, if not to Dr. Porter's satisfaction, to the satisfaction of many, the origin and growth of altruistic sentiments, and that it is not correct, therefore, to speak as if that philosophy wholly failed to grapple with the question.

It is remarkable how free the ex-President of Yale seems to feel himself to treat *de haut en bas* the leaders of modern evolutionary thought. He twitted them, it will be remembered, with not knowing how to state their own case to the best advantage. He now talks of "the dreary and meaningless theories" of Spencer and Lewes, and smiles at the "*naïveté*" of Spencer in acknowledging that he had found the germ of his system in the philosophy of Wolff. Then of Spencer's application of Wolff's idea he says, "There never was a profound spiritual truth more ignominiously misinterpreted and more basely perverted to earthly uses." We should like much to see the evidence that Spencer had misinterpreted Wolff. According to Dr. Porter, to misinterpret a writer is apparently to accept some thought contained in his writings, but to develop and apply it differently from what he had done; and to confess the obligation is "*naïveté*"! Really, the ex-president is teaching us some strange lessons.

Perhaps he (Spencer) "was incapable," our critic haughtily remarks, "of discerning the difference between a homogeneity in matter, necessarily and blindly tending toward a heterogeneity, and such a law of organism [*sic*], progress, and growth as requires a spiritual intelligence to originate and maintain it." Perhaps he was, poor man! or perhaps he thought he had better discern and formulate progress where he could do it to the best advantage, and leave the postulating of spiritual intelligences to those who had a greater talent than he for building in the region of the unverifiable. It would have been "far more creditable" to Spencer, Dr. Porter remarks, if he had taken the pantheistic theory for better or for worse, in lieu of his own conclusion in favor of an Unknowable Cause of all things. It will occur to some, we think, that Herbert Spencer's "credit" is quite as safe in his own keeping as it would be in his critic's.

Let us, hasten, however, to the conclusion of the whole matter. Dr. Porter's final position is that "evolution, as a consistent theory, in its logical outcome will be found to give a material substratum and material laws for the human spirit; to involve caprice in morality,

tyranny in government, uncertainty in science, with a denial of immortality and a disbelief in the personality of man and of God." Here we distinctly join issue. Evolution, as taught by Herbert Spencer, does nothing to weaken the fundamental distinction between subject and object, between mind and matter. If Spencer teaches that both these aspects of existence may, or rather must, find their union and identification in the Unknowable Cause, he does no more and no less than the Christian, who believes that God is the author both of the visible world and of the human spirit. Evolution gives material laws for human thought, only in so far as it shows the dependence of each higher plane of life on those below it; but, inasmuch as it also shows the reaction of the higher on the lower, it does as much for the establishment of liberty as for the demonstration of necessity. As to involving caprice in morality, that is precisely what it does not do, but what theological systems, referring the criterion of right and wrong to a personal will, always have done and always will do. The proof is simple and conclusive. Wherever morality has disengaged itself from theology, there it has shown a tendency to develop along the same lines. Wherever it has been complicated with theology, there it has always been more or less incalculable and capricious; we may add, more or less perverted and debased. As to tyranny in government—the thing is almost too preposterous to discuss—every child knows that the days when evolution would have been treated as a damnable heresy, to be extirpated by fire and sword, and when a spiritual philosophy was supreme, were precisely the days of the most odious political tyranny; and that to-day, step by step with the advance of the philosophy Dr. Porter so much detests, political administration is becoming milder and more equitable. "Uncertainty in science"—what are the proofs of it? Was there ever a time when science was surer in its methods, or more fruitful in its results, than it is to-day? What did the spiritualistic philosophies of the past ever do for science except to embarrass it with arbitrary hypotheses, and to stand in the way of the recognition of the natural causes of phenomena? Did it help the understanding of disease to explain it as a chastisement for sin? Was the old doctrine of demoniac possession—so strongly countenanced, unfortunately, in the New Testament—an aid toward the scientific treatment of insanity? Did the general belief in ghosts and devils help to rationalize men's thoughts? We think that answers should be given these questions before we are asked to accept the statement that the doctrine of evolution will lead to "uncertainty in science." The fact is, that the hold which evolution has to-day upon the scientific world is due principally, as Dr. Dallinger observes, to its proved utility in a great many different fields of scientific investigation. The man of science, we may be sure, will not be slow to discard it, when he finds it beginning to lead him astray and vitiate his scientific labors.

Finally, as to the relation of the evolution philosophy to the belief in immortality and in a personal God. When Darwin was asked by some one whether his theories were consistent with faith in Christ, he answered that they had no bearing upon faith in Christ, except in so far as they might render those who adopted them exceedingly careful as to the evidence for any belief or opinion presented for their acceptance. The answer was a good one; and a somewhat similar answer may serve us here. The doctrine of evolution is simply a mode of conceiving and accounting for the succession of events on the earth. It is in no sense a metaphysical or ontological doctrine, and lays no claim to the absoluteness with which metaphysical and ontological doctrines are invested. It does not pretend to penetrate to essences or to unveil final causes. If it is regarded by some as solving all mysteries, that is simply because they do not adequately understand it. Mr. Spencer certainly has never given countenance to such an idea. It does, however, as Darwin said of his philosophy, call constant attention to the need for proving all things. It strikes at the idea of authority, always excepting the constitutional authority, as we may term it, of demonstrated truth. What is troubling the theologians to-day is that it is making good the claim advanced by Christian Wolff for philosophy, namely, that it should embrace the whole domain of knowledge. There may be a great deal of wild talk about evolution on the part of people whose ideas on the subject are crude and superficial, just as there is a great deal of wild talk about art and about politics among people who know next to nothing of these subjects. Nevertheless, one good effect is everywhere apparent—the growing demand for proof in lieu of dogma. Now, the doctrine of immortality is just in this position, that, heretofore, it has been accepted upon authority—upon the same authority as that upon which the most preposterous fables have been given out as solid truth. That authority is discredited, and among the intelligent classes is becoming more so from day to day. The doctrine of immortality, therefore, has to seek out new proofs; and up to the present it is still engaged in the quest. That an emotional longing for immortality is common among men is no doubt true; and, if that is a ground for believing in it, then the case may be considered proved. Those upon whom the methods of modern science have taken hold will probably ask for more conclusive demonstration.

The idea of God, again, is compromised to some extent in the same manner as the doctrine of immortality, namely, by the discrediting of the authority upon which it has been taught. It has now to maintain itself in the open field of philosophy. To say that it is found in the Bible, and is to be believed because it is there, is no longer sufficient. In the present state of thought, the belief in God must be borne in upon the human mind, as the result and consummation of all its activities, or it will certainly lose ground. If Dr. Porter can teach, with

power and demonstration, a philosophy that will place the belief in God upon unassailable ground, not only will he encounter no opposition from evolutionists, but he will, we undertake to say, receive their hearty thanks for removing out of the way a question which, though not properly belonging to their field of thought and labor, has too often been made use of, maliciously or ignorantly, for their annoyance. It is needless, we hope, to say that the demonstration would in no way affect the practical work of scientific investigation. The constancy of natural law is the one essential condition of scientific progress; and, that datum remaining, men would still seek to know what is in the present and what has been in the past; and would still regard the world as Wolff regarded it, as "a series of changing objects which exist conjointly and successively, but which are so connected together that one ever contains the ground of the other." * Dr. Porter does not himself seem to be of a very different opinion, for (page 31) he sees no objection to "connecting the scientist with the original star-dust," so long as we consent to do so through "the progressive complications of a slowly developed thought of the living and loving God." If Dr. Porter really understands how the progressive complications of a thought could facilitate the conversion of star-dust into a scientist, he stands on a proud intellectual eminence; and it is no wonder if he feels that he could school the whole evolutionist tribe, from Darwin and Spencer down. It is, however, going a long way with the evolutionist to believe that, by the aid of a few thought-complications, the star-dust could be brought to take so improved a form; and the evolutionist will not quarrel with him for his proviso. The evolutionist does object, however, when he is told that certain "artificial lines of progressive evolution may become luminous with thought when projected against the bright background of the living God." He says: "No; things do not become luminous when placed against a bright background; they become dark." †

Had we space we might notice some, no doubt unintentional, misrepresentations of Mr. Spencer's philosophical position, particularly in regard to his alleged demand for "faith." We must leave this undone, however, in order to make a few concluding remarks. Dr. Porter, we are sure, can not but feel that the present time is a critical one. The numerous attacks that have lately been made upon the theory of evolution, and generally upon the rationalism of the age, show that the defenders of ancient opinions feel that something must be

* Schwegler, translated by Seelye.

† The evolutionist is also driven to wonder what can be the state of English composition at Yale when the ex-president, in what was meant to be the most impressive part of his lecture, writes as follows: "Why, then, may he [man] not be worthy of the constant care and fatherly love of Him who has had him in His thoughts from the beginning till now, and *toward whom* His plans and movements have ever been tending?"—(Lecture, p. 32.)

done, or all the world will go after the new lights. Well, we too are profoundly convinced that something must be done. We have, on the one hand, ministers of religion and doctors of divinity denouncing modern science as godless; we have, on the other hand, men of science showing by their practice, if not by words, how little weight they attach to clerical objurgations. The priests proclaim that the dominant scientific philosophy destroys the sense of moral obligation; nay, more, destroys the ground of moral obligation. The scientists reply, in effect, that their philosophy is true, and that moral obligation must take care of itself. The situation is dangerous. It is a dangerous thing to tether moral obligation to outworn creeds; and it is an almost equally dangerous thing to formulate new principles of scientific inquiry, without clearly and frequently exhibiting the provision they make for the regulation of conduct. On the part of the theological world, there has been too much of frowning opposition to inevitable change; on the part of the scientific world too much gayety of heart in setting out for new destinations. The theologians have, for the most part, repulsed as a foe what they should have hailed as a friend; and the scientists have not shown quite enough consideration for the weaker brethren to whose convictions their new speculations were giving a shock.

We think, therefore, that there has been error on both sides, and that it is now high time the whole matter should be considered, as it were, in joint committee. The word has gone forth: morality must stand on a basis of natural law, or it can not stand at all. God can not make morality. He has to be moral Himself first before He can even sanction it; and, if we know God as moral, we know morality apart from the idea of God. The problem of the day, therefore, is the formulation and enforcement of a natural morality—a morality resulting from the nature of man and the conditions of his existence. We have to look the Universe in the face and question of it what it would have us do; that is to say, on what terms the harmony and happiness of human life are to be won. Heretofore men have trusted to names—to Moses and Manu, to Jesus and Buddha, and have received, at the hands of these, laws that were in reality the embodiment of human experience; but the time is coming, yea, now is, when law must take on an impersonal character and be obeyed as law. There is no uncertainty as to the fundamental principles of morals; but we have weakly allowed ourselves to think that the authority of all moral teaching is bound up with certain traditional doctrines. That is the cardinal error which earnest men should strive with all their power to banish. If there are signs among us of a relaxation of moral discipline, they can be accounted for, we think, by the fact that moral instruction has been becoming, for some time past, less and less a domestic matter, and more and more the function of a professional class. It was not through any professional class that Moses proposed to provide for the moral educa-

tion of Israel. "These words that I command thee this day shall be upon thine heart: and thou [not the minister or the Sunday-school teacher] shalt teach them diligently unto thy children, and shalt talk of them when thou sittest in thine house, and when thou walkest by the way, and when thou liest down and when thou risest up." How little this is done in Christian families to-day may be gathered from President Seelye's recent article in "The Forum," where he urges the utter insufficiency of the domestic teaching of morality and religion as a reason why the State should take the matter in hand. If, therefore, ex-President Porter and President Seelye, and all the other great educators of our time, want to render a signal service to the State, let them unite in earnest and continued efforts to revive the domestic teaching of morality. Let them strive to persuade Christian parents that it is more important for their sons to be honest than to be rich; more important for their daughters to be pure-minded, rational, and womanly than to be fashionable; and there will soon be a wonderful change in the moral tone of society. But so long as men like these stand apart, thundering against the methods of modern science, and representing moral authority as inseparable from supernatural creeds that are daily becoming more difficult of acceptance, so long will a very hurtful degree of uncertainty as to all moral law prevail in the community. The only escape from a situation that really threatens moral anarchy lies in the recognition of the fact that the Universe, as related to man, has lessons to teach; and that these, revealed as truths of reason to the mind and conscience, are not less authoritative than if thundered on affrighted ears from the cloud-wrapped summit of Sinai.

GENIUS AND PRECOCITY.

By JAMES SULLY.

II.

MEN OF SCIENCE.—Instances of astounding precocity do not fail us when we leave the more romantic walks of art and letters for the austere region of science. Mathematical genius and original power in physical research have alike been frequently heralded by exceptional boyish endowment.

Among the greatest discoverers we have instances of juvenile distinction. Galileo showed remarkable aptitude from earliest childhood. His favorite pastime was the construction of toy machines. A passion for music did not seduce him from his supreme devotion to mathematics, and by nineteen he was making important discoveries. Tycho Brahe illustrates the same early bent in a slightly different way. His devotion to astronomy had to contend, not with his own, but with

others' inclinations. Sent to read law at sixteen, he managed, after the day's studies, to pursue his astronomical observations, passing whole nights in his favorite occupation. Newton, like Galileo, occupied his playhours at school with constructing model machines (water-clock, windmill, etc.). By the age of twenty-three or twenty-four he had conceived roughly his chief epoch-making discoveries. Another English investigator, Thomas Young, was a striking example of precocity. He read with fluency at two. He showed extraordinary avidity of mind in very different directions, now busy mastering the difficulties of Oriental languages, now set on constructing a microscope for himself. His mind, unburdened with its weight of learning, was nimbly tracking out new truths in optics by the age of twenty-nine.

Recent English biography supplies us with two of the most signal illustrations of the precocity of the mathematical mind, viz., Clerk-Maxwell and Sir William Rowan Hamilton.

Among naturalists, too, examples of well-marked if less astonishing precocity are to be met with. Linnæus as a boy showed so decided a bent to botany that, through the advocacy of a physician who had remarked the early trait, he was saved from the shoemaker's shop, for which his father had destined him, and secured for science. At the age of twenty-three we find him lecturing on botany, and superintending a botanical garden, and at twenty-eight he begins to publish his new ideas of classification. Cuvier's history is similar. A poor lad, he displayed an irresistible impulse to scientific observation, and by twenty-nine published a work in which the central ideas of his system are set forth. Humboldt, again, showed his special scientific bent as a child. From his love of collecting and labeling plants, shells, and insects, he was known as "the little apothecary." At twenty he published a work giving the results of a scientific journey up the Rhine. In medicine, Haller is a notable instance of precocity.

Since Science has academical and other appointments to bestow on her distinguished votaries, we may estimate the precocity of scientific men by noting the early age at which such posts have been won. Laplace was mathematical teacher at a school when a mere lad ; Lagrange was professor at eighteen ; St. Hilaire at twenty-one ; Kepler, Euler, Linnæus, and Davy at twenty-three ; Cuvier at twenty-six ; Copernicus at twenty-seven ; and Tycho Brahe at twenty-eight. Others have obtained academic honors at an early age ; among these, Lavoisier, Lyell, and Clifford.

Following our general plan, we have to ask what proportion of eminent *savants* have shown signs of precocity. I find, after going through a list of thirty-six, that twenty-seven, or three fourths, have given distinct evidence of a bent to science before twenty. Of the remaining nine, five appear to have first taken to science after this age, while in the case of four the question is left doubtful.

Looking now at the age of productivity, we obtain the following

results: out of a list of thirty-one, seven certainly wrote memoirs or other works under twenty; fifteen gave out their first known production between twenty and twenty-five; three began to write between twenty-five and thirty; leaving six who, so far as I can judge, entered on the productive stage after thirty.

If, again, we ask at what age fame, or the achievement which entitles to fame, is reached, we obtain the following figures: Out of a group of thirty-seven, fourteen reached this point before twenty-five, twelve between twenty-five and thirty; eight between thirty and forty; while three did not rise to the height of renown till after forty.

In science, as in the more serious department of letters, fame is sometimes reached suddenly by the production of a great work, the fruit of many years of study. Harvey's publication of his great discovery at the age of fifty is a case in point. It is to be remembered, however, that Harvey had expounded his theory in lectures some twelve years before this date. And the same kind of remark applies to Darwin and others who first gave to the world epoch-making truths at a somewhat advanced age; we commonly find that the actual discovery dates from a much earlier period, the promulgation of it being deferred till it was ready to be presented in a definite and verified form. The case of Franklin making his first, and this a capital, scientific discovery toward the age of fifty is, so far as I can gather, exceedingly rare, if not, strictly speaking, unique.

Philosophers.—If philosophy precedes science in the historical development of the race, we need not wonder at meeting with instances of youthful speculative genius. Coleridge is not the only case of a lad of fifteen having his head seething with metaphysical puzzles. But Coleridge, it may be said, never developed into an original thinker; and what we require is proof of the early manifestation of genuine philosophic originality.

Passing by the romantic story of Abélard dazzling Paris and Europe with his dialectics at the age of twenty, and coming to the modern period, we note that the most conspicuous instances of philosophical precocity are supplied by the history of British philosophy. Berkeley, as his commonplace-book shows, hit on his new principle of idealism at college when only eighteen, an instance of metaphysical audacity to which there is no parallel. His "New Theory of Vision," perhaps the most epoch-making work in the history of psychology, appeared when the author was twenty-four. His immediate successor, Hume, displayed speculative ability when very young, and was regarded by his mother as an "uncommon wake-minded" lad. His "Treatise of Human Nature," probably the work of modern times which has proved most stimulating to further inquiry, was thought out between the ages of twenty-three and twenty-six. And, oddly enough, Hume's most distinguished follower, J. S. Mill, has supplied the best recent example of philosophic precocity.

Among foreign metaphysicians, the two who come nearest to the above are Leibnitz and Schelling. Leibnitz was, like Mill, a prodigy of youthful learning, and began from the age of seventeen to write on a variety of subjects. His bent to philosophical reflection betrayed itself at the age of fifteen, when, at the University of Leipsic, he was entertaining the idea of rejecting the scholastic doctrine of "substantial forms." His first philosophical publication was the "Bachelor's Dissertation," which falls in the eighteenth year. But, after this, Leibnitz abandoned philosophy in favor of politics; so that he did not attain the rank of a great philosophical teacher till the age of forty-four. Schelling, if a less remarkable example of omnivorous learning than Leibnitz, is a more signal instance of precocious metaphysical constructiveness. He graduated at the early age of sixteen, taking "Myths" as the theme of his dissertation. He had written three philosophical works before the completion of his twentieth year.

Following the same plan as before, I have tried to determine the proportion of the precocious to the non-precocious among thinkers. Taking thirty-seven eminent representatives, I find that twenty-five, or about two thirds, appear to have shown a marked philosophical inquisitiveness before the age of twenty.

If now we go on to ask at what age philosophic production begins, we arrive at the following results: Among thirty-six, two wrote on philosophical subjects before the age of twenty; eighteen between twenty and thirty; eight between thirty and forty; and eight after forty.

Finally, with respect to the age at which greatness reveals itself in a remarkable achievement, we gather the following data: Out of thirty-five, three distinguished themselves before twenty-five; four between this date and thirty; fourteen between thirty and forty; six between forty and fifty; and eight after fifty.

Of those who achieved philosophic distinction after fifty we have no less illustrious names than Descartes, Hobbes, Locke, and Leibnitz. It may be added that Kant very nearly falls into this category, his first independent treatise appearing at the age of forty-six. The lateness of achievement in many cases is connected with the circumstance that other subjects, as mathematics, have been taken up before philosophy.

In presenting these statistics of genius, I am not unmindful of the defects of the evidence. Thus, for example, there are the gaps in the record of the childhood of great men which all the industry of recent biographical research has not been able to fill up.* Even where we do know something of the early life, we can not be sure that we have

* I have found the determination of dates in the case of the Italian painters particularly difficult for this reason. Old Vasari, in his "Lives," is very chary of figures, and, when he does venture on a date, he is very far from trustworthy.

a full and accurate account of the intellectual and moral idiosyncrasy. For, on the one side, there is the inability of parents, etc., to recognize the marks of natural distinction. But few gifted children have been privileged to have their sayings and doings observed and treasured like Clerk-Maxwell or Rowan Hamilton. On the other side, something in the way of overstatement must probably be set down to the exaggerative influence of family affection, and also, perhaps, to the action of the mythopœic impulse in endowing those who have attained greatness with a worthy origin in the shape of a distinguished childhood.

Since these two sources of error tend in opposite directions—to an underestimate and to an overestimate of the indications of precocity—we may perhaps assume that they roughly counterbalance one another. And, so far as there is any appreciable residual error, it would seem to be in the direction of understatement of the case.

We may now inquire into the meaning of our figures, and the conclusions to be drawn from them.

A glance at our different lists will show that throughout precocity preponderates. This will be made more apparent by the following figures: Taking the seven lists together, I find that of the cases examined 231 out of 287, or about four fifths, displayed talent before the age of twenty. The instances of those who gave no sign of their high destiny in their youth must accordingly be regarded as exceptions to the general rule.

I may add that these exceptions, or, to be more accurate, these apparent exceptions, include only one or two names of the first magnitude. I doubt, indeed, whether one could find in the lists of musicians, artists, and poets, a single clear instance of a man of supreme genius having failed to give these early indications.

In the second place, our inquiries teach us that in the large majority of cases the productive period of genius begins early. Thus, in a total of 263 cases, 105—i. e., just two fifths—are known to have produced works before twenty; or 211—or more than fourth fifths—before thirty. At the same time these figures plainly show that there is less uniformity in this particular than in the other.

In the third place, we gather from our investigations that a large majority of great men gain their first considerable success in early manhood. Thus, out of 258 cases, 101, or nearly two fifths, reach this point before twenty-five; and 155—in all about three fifths—before thirty. But the proportion of exceptions becomes decidedly larger here. Thus we have thirty-one instances, or nearly one eighth of the whole, only attaining distinction after forty. And among these are names of very high, if not the highest, eminence.

It follows that there is only a general and not a perfect consilience with respect to the different marks of precocity here selected. The

men who disclose the germ of a great intellect in boyhood are, as a rule, early in production, and in the attainment of an assured place among the great. At the same time, there are noteworthy deviations from this rule. Thus, Bach, Haydn, and Wagner in music, Perugino and Gainsborough in painting, Dante and Dryden in poetry, Cervantes and Scott in fiction, Gibbon and Niebuhr in scholarship, Copernicus and Darwin in science, and, finally, Descartes and Leibnitz in philosophy, are all instances of early promise followed by comparatively late performance.

The explanation of these facts seems to me to be the following: Genius, as the etymology of the word suggests, is essentially a native quality. A truly great man is born such. This means that he is created with a strong and overmastering impulse to a definite form of origination. And hence he commonly gives a clear indication of this bent in the first years of life. On the other hand, actual production presupposes other conditions as well. It implies, for example, a certain amount of physical vigor, a possession which many a son of genius has had to do without in the early years of life. Not only so, production on any considerable scale requires opportunity and leisure. And here the external circumstances become a matter of importance, as serving to further or to delay the process of achievement. For though it may be true that in the end real genius proves itself irresistible in its instinctive striving toward creation, every reader of great men's biography knows that parental disapprobation, aided by the necessity of living, from which even the most gifted of mortals is not exempt, has in a large number of instances greatly retarded the process of production and the attainment of distinction.

I do not, however, consider that these causes account for all the exceptions. After allowing for the effect of delicate health and external obstructions there remain a certain number of instances of late achievement which are only explicable as illustrations of a slow process of development. In a number of cases, the postponement of the fruitful effort has been due to the individual's own volition and not to external compulsion. Thus Dante, Milton, Cervantes, and others voluntarily passed their early manhood in active life, rather than in the life of imaginative creation, showing that the impulse to poetic creation was not at this period supreme and overpowering. In other cases, again, there is reason to suppose that the creative faculty unfolded itself slowly. What Macaulay says of Bacon is apparently true of more than one imaginative writer: the judgment developed in advance of the fancy. Defoe seems to be an example of such a late development of imaginative power, and George Eliot is a clear and very remarkable instance of this faculty first revealing itself at a comparatively late period. If to these considerations we add that men of genius vary considerably in their rate of production, that to many the process of creation is a slow, tentative progress, rather than a sud-

den achievement, we have, I imagine, a fairly complete explanation of the facts.

If now we compare the results in the different groups we reach other interesting conclusions. Speaking roughly, one may say that the numbers showing distinct promise before twenty in the several classes are represented by the following fractions:

	Musicians	$\frac{19}{20}$
	Artists	$\frac{8}{9}$
	Scholars	$\frac{5}{6}$
equal	Poets	$\frac{3}{4}$
equal	Novelists	$\frac{3}{4}$
equal	Men of science	$\frac{3}{4}$
	Philosophers	$\frac{2}{3}$

In order, however, to get a just idea of the relative proportions of the several classes, we must further compare them in respect of the date of the commencement of the productive period and also of the age at which distinction is attained. If we take work before thirty as representing early production, we find the proportions in the different groups to be approximately as follows:

Musicians	$\frac{1}{1}$
Artists	$\frac{41}{42}$
Poets	$\frac{11}{12}$
Scientists	$\frac{4}{5}$
Scholars	$\frac{5}{7}$
Philosophers	$\frac{5}{9}$
Novelists	$\frac{9}{16}$

Finally, with respect to the age of distinction, we learn that the following proportions attain this point before forty:

* equal	Musicians	$\frac{1}{1}$
* equal	Artists	$\frac{1}{1}$
equal	Poets	$\frac{11}{12}$
equal	Scientists	$\frac{11}{12}$
	Scholars	$\frac{9}{10}$
	Novelists	$\frac{4}{5}$
	Philosophers	$\frac{3}{5}$

It will be seen at once, on comparing these tables, that on the whole the order of the classes in point of precocity corresponds pretty closely with the order in which we have examined them. Musicians and artists stand at the head of the list throughout, and philosophers come last in two out of three of the scales. On the other hand, the relative position of the intermediate groups—poets, scholars, novelists, and scientists—varies considerably in the different scales.

Without attempting an exhaustive explanation of these figures, a remark or two may be hazarded as to the more potent influences at work:

* If we make twenty-five the limit, we find that artists just surpass musicians.

First of all, then, we note that the order in respect of precocity answers roughly to the degree of abstractness of the faculty employed. At the one extreme musicians and artists represent sensuous faculty, or the least abstract mode of mental activity, while philosophers at the other extreme illustrate the highest degree of abstraction. Between these come the men of imagination, the poets and novelists. And this is the very order we should antecedently expect from a consideration of the general laws of intellectual development; for sense, imagination, and abstract thought are the three well-marked stages of intellectual progress. Or, to express the same fact in physiological terms, one may say that the nerve-centers specially engaged in the production of sense impressions, mental images, and abstract ideas, develop and are perfected in this order.

Taking up the classes *seriatim*, one may say that the clear primacy of musical genius is probably connected with the fact that the faculty for music has, as its main ingredient, a very special and restricted sense-endowment, viz., a fine sensibility to tones and their musical relations, which, again, seems to be correlated with a special functional endowment of the organ of hearing. One may add to this that musical inventiveness presupposes no experience or knowledge of things, but merely an accumulation of tone-material.

Painting, like music, seems to depend on a special sense-endowment, viz., an eye for form and color, and also a finely organized hand, which endowments might be expected to be well marked from the first. On the other hand, it involves much more in the way of external observation and a knowledge of objects. Hence, perhaps, its inferiority to music in the matter of precocity.

Passing to men of letters, we find that, on the whole, poets are the most precocious class. Here, too, we note the presence of a clearly marked sensuous ingredient, viz., a fine ear for rhythm and the musical qualities of verbal sounds. The poetic endowment includes, moreover, as a principal act, or a lively, sensuous imagination, a faculty that is in a manner based on a certain degree of perfection of the senses, and so may be expected to become prominent at an early period of life. If to this we add that lyrical poetry is to a very large extent the expression of erotic and kindred feelings which are known to be developed in great strength during the transition from childhood to youth, we are able, I imagine, to understand much of the daring precocity of poets. It is to be remarked that, though there are several instances of boys writing comedies, dramatic composition begins as a rule considerably later than lyrical, and this accords with the fact that dramatic conception presupposes much more objective knowledge of men and things.

The next class to claim attention is the scholars. At first one may well be surprised to find these so high up in our first table, for the critical faculty, judgment, is known to be late in its development. But

the anomaly is only an apparent one. The scholar, the historian, and the critic are alike dependent on an exceptional power of acquisition and of memory, and this is well known to be a precocious endowment. Moreover, it is an endowment which is fairly certain to be duly noted, seeing that it is precisely the aptitude which is at the basis of school-renown. This is borne out by the fact that the class of scholars, etc., though high up in respect of early manifestation of ability, are not so distinguished in the matter of early production or of early attainment of excellence.

The next group in our combined scale of precocity is scientists. Their high place is, I believe, largely owing to the mathematicians. The mathematical faculty is well known to be a precocious one. The fact that it is often found in the company of musical capacity suggests that there is a common mental ingredient. In each we note the play of inventive imagination on a circumscribed mass of material easily acquired, viz., tone-images in the one case, and symbol-images in the other. On the other hand, the representatives of the natural sciences which involve prolonged processes of observation, etc., are much less forward.

The shifting position of novelists in our three scales is, perhaps, the most curious outcome of our investigation. Like the poet, the novelist employs as his chief mental implement the faculty of sensuous imagination. Hence the relatively high position in our first table. At the same time the novel presupposes much more in the way of knowledge of the world and reflection on its ways than the poem. Its most distinctive aptitude, perhaps, is a minute knowledge of character; a circumstance which brings it into close relation to one of the most abstract of the sciences, viz., psychology.

Respecting philosophers little need be said. That a considerable fraction should begin to write after thirty, and almost as large a proportion attain fame after forty, is just what one might antecedently expect. Indeed, nowhere perhaps is early achievement so truly marvelous as in the severe domain of abstract speculation. It is not a mere coincidence, I take it, that the two most brilliant examples of this precocity, Berkeley and Schelling, are metaphysicians whose writings are so deeply tinged with the glow of a poetic imagination.

In this attempt to explain our results we have confined our attention to the intellectual ingredient in genius. But we might also take into account the emotional and volitional factor—that is to say, the specific impulse which prompts and sustains the creative activity. And by so doing we might still further illustrate the general agreement between our facts and the laws of mental development. Thus, for example, the artistic impulse, which according to our tables shows itself to be most precocious, appears also to be the one first manifesting itself in a decided form in the history of the average individual, and of the race. The child and the race alike develop a crude art before they

take seriously to inquiry. How far this consilience extends with reference to the relative position of the several classes in our scheme I will not now venture to say.

Genius is precocious, then, in the sense of manifesting itself early. But what of its subsequent history? Does it soon attain the summit of its development, or go on improving as long as, or even longer than, ordinary intelligence? This, as was pointed out at the beginning of this essay, is, in a measure, a different inquiry, and one too long to follow out here. There are special difficulties, too, in pursuing this line of research. Although it is, in a general way, an easy matter to say when a man of genius produces his first distinctly original work, it is exceedingly difficult to determine how long he goes on improving. Critics are far from agreed, for example, as to the relative value of the earlier and later work of Goethe, Beethoven, Turner, etc. It may, however, be safely asserted that early manifestation of genius is not incompatible with a prolonged and even late development. Haydn, Beethoven, Michael Angelo, Titian, Milton, Goethe, Voltaire, Gibbon, Lessing, Newton, Leibnitz, Berkeley, Mill, and other great names, are examples of such a lengthy process of development. Indeed, there is much to support Mr. Galton's view that eminent men surpass ordinary men not only in superiority from the first, but also in a more prolonged development.*

Such a conclusion, it may be observed, would seem to accord with what we know of the general laws of mental evolution. For, if we compare the different races of man, or the different species of animals, we find that, in general, the higher the cerebral organization attained, the longer the process of development. Men of great original power, having the most highly organized type of brain, may be expected to illustrate the most prolonged movement of mental growth.

From this point of view we are able, I think, to see the difference between the course of development of a truly great intellect, and that of a precocious but stunted intelligence. That there are many clever children that never "come to anything," or, at least, do not fulfill their early promise, is a fact which nobody, probably, will deny. Some of these would perhaps have distinguished themselves if they had had better opportunities, or, at least, more ambition and energy of character. But, allowing for this, one finds a good remainder of youths who appear to have had a rapid but early arrested mental development. Such an early display of quickness, followed by a lengthy period of ordinary mediocrity, or even dullness, looks like a too great forwardness of ordinary human ability. In other words, the clever child is in this case not an exceptional being, but a quite average one, whose cerebral development has somehow outrun the common attainment of his years. He is like a tree that bears fruit too soon. On the other

* See "Hereditary Genius," p. 44. Mr. Galton has kindly sent me a fuller statement of his view on this point.

hand, the man of superb ability is precocious just because, having a finer brain to start with, he is raised above the average mental stature of his years. He rather resembles a tree which shoots at once above the surrounding trees, though it may mature and bring forth fruit later than they.—*Nineteenth Century.*

[*Concluded.*]

WOODS AND THEIR DESTRUCTIVE FUNGI.

By P. H. DUDLEY, C. E.

II.

AT the close of my former article I described the conditions which are favorable to the growth of the fungi on woods. In this article I present a few examples under similar conditions, to show what takes place as the result of such growth.

Fig. 10 is a representation of a typical example of decay at and below the ground-line of railway-signal and telegraph poles, sign and fence posts. In the case illustrated, as in a large number of other cases, the sap-wood forms part of the pole, the bark only being removed. At the ground-line the ever-present spores of some of the fungi have germinated, under the influence of the moisture, warmth, and air, and have sent out their delicate mycelia over the wood, the threads penetrating any season cracks or fissures, thence piercing and growing in the wood-cells; the manner of growth is not only interesting but wonderful, and almost leads one to think, for an instant, that the fungi, like animals, have instincts to protect them in their development. Certainly I do not wish to convey that impression, but rather to assert the fact of their certain growth and the consequent destruction of the wood, when the conditions before mentioned are present.

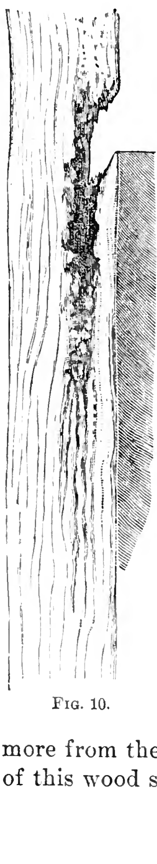

Fig. 10.

The figure shows a section from a telegraph-pole of black spruce (*Picea nigra*); the opening at the ground-line was sufficient for the admission of the necessary air to carry on the development of the mycelia and the fermentations, but not large enough to allow the wind and heat to dry up the moisture and check the decay; nor was the opening made until a long time after the internal decay was well advanced, the breaking away of the tissues of the wood occurring more from the inside than the outside. In unpainted poles especially of this wood so exposed to the sun that an exterior shell may be dried,

or in painted poles, the decay does not appear above the ground-line on the exterior until after the breaking away of the interior wood-cells. In chestnut poles, the sap-wood being so much thinner, the cells break away sooner than in the spruce.

From the place of growth at the ground-line the mycelia pierce the upright longitudinal cells more readily than they do those of the medullary system, growing up and down, but faster in the latter direction, from the fact that the moisture is retained below the ground-line in greater abundance than above. Accompanying the mycelia is a growth of ferments, either of the *Schizomycetes* (bacteria) or the *Saccharomycetes*, depending somewhat upon the particular fungi and the wood. These aid in carrying on the destruction by producing fermentations, which extend down the wood-cells preceding the growth of the mycelia. The illustration was prepared from a pole of which five feet in length of the base was in the ground, and decay had followed down the cells four feet, while above-ground the decay only followed up the cells a few inches; the pole being unpainted allowed the moisture to escape sufficiently to retard the upward growth. It will be seen from Fig. 10 that a few inches below-ground the exterior of the wood is not so quickly affected, and, comparatively speaking remains sound until destroyed from the inside, though retaining the moisture and facilitating the growth of the fungi. This illustrates one of the important principles to be observed in the care and preservation of our timber in structures, for it will be seen that exterior protection to unseasoned timber, or to that which is to be in a damp situation, retains the moisture and hastens internal decay.

In the case of painted posts above the ground the paint prevents the escape of the moisture, the mycelia and fermentations grow farther up the cells and the posts often break off on the inside above the earth, while appearing sound outside, with a cone-shaped fracture.

In Fig. 10 the decay was extending toward the center of the pole very slowly, the fermentation not being communicated with as great rapidity by the medullary cells, which are only one fifth to one third as large as the upright cells.

Fig. 11 shows the tangential section of the tamarack, which is quite similar to that of the black spruce. The three largest bundles of rays contain resin-ducts, while the cell-cavities of the rays can just be seen; also the sections of the lenticular markings on the walls; in Fig. 12, they show in position on the walls parallel to the medullary rays; the latter are the lines partly crossing the cut, and composed of short contiguous cells, which are thick-walled and not easily penetrated by the mycelia or destroyed by fermentations. An example of the slow lateral extension of the decay is found in the white cedar, a transverse section of which was shown in Fig. 2 (see August number). In growing trees of this wood some of the lower limbs often die, and, not breaking off close to the body, the fungi grow before the wound heals

and start decay in some of the upright wood-cells. Ties from such trees show decayed spots from one half-inch to an inch in diameter which extend through their entire length of eight feet. When the wounds close up, the decay is checked, and the wood is so durable that the ties are mechanically destroyed in the track before the decay spreads from the spots so as to render them unserviceable.

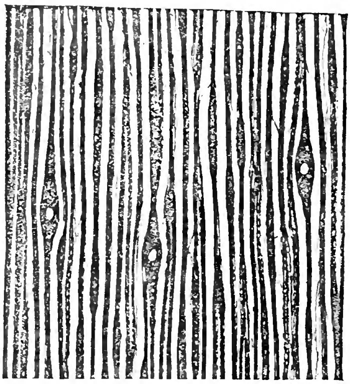

Fig. 11.—Tangential Section of Tamarack, $\frac{20}{1}$.

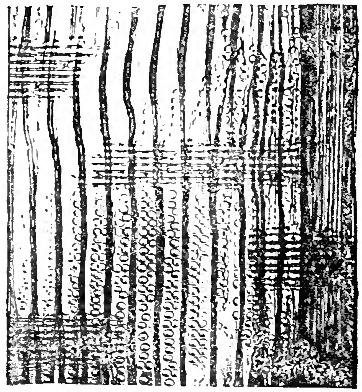

Fig. 12.—Radial Section of Tamarack, $\frac{50}{1}$.

The manner of decay shown in Fig. 10 is quite similar in principle to that occurring in double bridge-planks; where the under side of the lower plank is exposed to the air, a thin shell from one eighth to one fourth of an inch thick remaining dry, checks the evaporation from below of the absorbed moisture from above, and decay takes place from the fact that the necessary conditions for the fungi to grow are supplied.

A large majority of fence-posts, especially on railways, are from small timbers, with the sap-wood remaining except on the face side; on those of chestnut and oak, *Polyporus versicolor*, Fr., Fig. 8 (see August number), will often be found fruiting near the ground-line, as seen in the figure, while its mycelium has already partially rotted the post. Many other species of fungi will also be found fruiting, though in a majority of cases the mycelia only will be seen. The bark should always be removed from posts or timber to be used in the ground, otherwise it will furnish means for a growth of mycelia, and the posts or wood will decay much quicker than otherwise would be the case. This is readily seen in the forest; dead trees with the bark on will be found more or less covered with fruiting fungi, the wood decaying with great rapidity, while those with the bark off remain sound for a longer time. A striking object in a forest abounding in birch-trees is to see on their dead trunks, of twenty to thirty feet high, ten to twenty specimens of *Polyporus betulinus*, Fr. (Fig. 13), from one to four inches in diameter, projecting from small openings in the bark, which clasps around their

necks and holds them with firmness; it is a sight once seen never to be forgotten, for their presence shows the decay that has taken place, and conveys an impressive lesson. The bark, like the coat of paint on unseasoned wood, has retained the moisture, the mycelia have grown, and the tree will soon be destroyed and fall to the ground. A study of the decay of trees in the forests teaches many lessons of great importance, and in practice to avoid as much as possible the conditions which there conduce to decay. That the decorticated tree does not quickly decay furnishes a fact of general application in the care and preservation of timber, teaching that wood will be protected by paint only when it is thoroughly seasoned or dry, otherwise the paint will furnish the artificial bark and hasten instead of retarding decay. Readers who are conversant with the decay of freight-cars will understand what must be expected from the use of

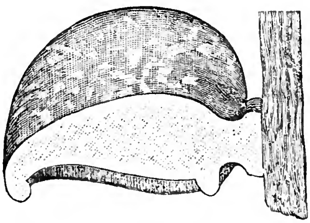

Fig. 13.

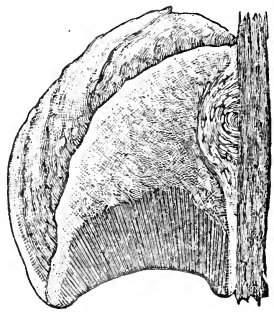

Fig. 14.

so much unseasoned lumber in their construction, and will comprehend the conditions furnished for the growth of fungi by the moisture inside of the cars retained by the outside paint. These facts must be more generally understood before the car-builder will be supplied with seasoned lumber. There lies before me as I write this a piece of timber from a building erected about eight years ago; to prevent the sills from decay, they were covered on three sides with asphalt, and tarred paper underneath the preparation; the wood was so badly decayed that they were replaced two years since. The wood was cracked longitudinally and transversely, the cracks being filled with the mycelia of the fungi which had destroyed it; upon drying, the wood crumbled to dust—the so-called "dry rot." Planks only two inches thick and eight inches wide were tarred on three sides at the same time, and were rotted under the tar over an inch in depth, while the unprotected side was sound. I did not see these timbers before they were treated, but they reveal their history as plainly as though the words were written upon them; the builder coated unseasoned wood, and produced the result he wished to avoid.

Fig. 14 is partly in vertical section, to show the pores in which the basidia grow bearing the spores.

On the under side of the various *Polyporei* here illustrated are the

pores, just visible to the eye in some species (see Fig. 6 in August number), from ten to twelve thousand occurring per square inch ; others are coarser and not so numerous. Minute as are these pores, their interior is studded with the basidia and spores, a few of which, magnified four hundred diameters, are shown in Fig. 15, where *a* represents sterile cells and *b* the basidia, usually having four sterigma, each of them bearing a spore.*

Fig. 14 represents a very interesting but destructive type of fungi, and, in one sense of the word, parasitic upon living trees. It is drawn from *Polyporus fomentarius* (Fr.), "Dingy-hoof Polyporus." Pileus ungulate, sometimes four to five inches broad, sub-triangular, obsoletely zoned, nodulose, brownish-gray, resembling coffee slightly tinged with milk ; its peculiar form and color make it easily identified. Closely allied to it are *Polyporus nigricans* (Fr.), Black-hoof Polyporus ; pileus pulvinate ; *Polyporus igniarius* (Fr.), Rusty-hoof Polyporus ; pileus at first tuberculoso-globose (immarginate) ; *Polyporus fulvus* (Fr.), Tawny-hoof Polyporus.

The first three are found upon beeches, willows, hornbeams, cottonwoods, and plums, and trees of similar characteristics, and grow upon live trees, where they have been injured by the breaking of limbs, or by the checking of other limbs, at the junction with the trunk of the tree. *Polyporus fulvus* (Fr.) is found upon the firs. The mycelia,

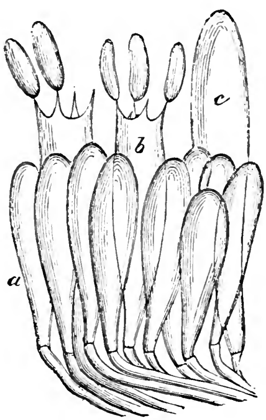

Fig. 15.

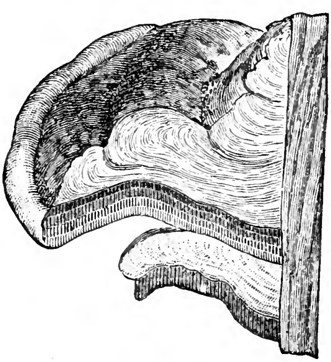

Fig. 16.

once started, will continue to grow in the heart-wood of the tree, while the sap-wood, with its bark, is still growing. If the wound is not closed by the growing tissue, the decay continues, causing hollows in the trees. These are not uncommon sights to those familiar with forests, and the trees almost seem to be conscious that they must keep their bark intact, or the invisible fungi will start and eventually destroy their stately proportions.

* From "Fungi: their Nature and Uses," by M. C. Cooke, M. A., LL. D., vol. xv of the "International Scientific Series."

A cut in a growing tree will be healed over in a few years, and in many woods, after twenty-five to thirty years, the scar can hardly be found. This fact will be recognized by those who have traced former land-surveys through the forests; upon rerunning the line, chopping into a supposed line-tree is often required to determine the question, the former wound having healed so perfectly as not to leave a scar.

Fig. 16, one fourth size, represents *Polyporus pinicola* (Fr.), partly in section to show the pores, also the apparent economy in the use of material in providing a surface for the growth of the spores, a succeeding forming over a preceding growth; on the upper portion the spore-bearing surface was renewed three times, and then new tissue pushed out underneath, and one set of pores formed before it was gathered. This fungus is found upon the firs and spruces, and is very destructive to planks of the latter, destroying those of two inches in thickness, in walks in from two to four years, while in station-platforms close to the ground, they do not last that length of time. One interesting feature in regard to this fungus is the quantity of phosphoric acid which was obtained from it by treating with necessary reagents. Potash and lime were also abundant. The watery extract from this fungus nearly resembles in composition the artificial preparations used for the cultivation of molds, and it undergoes fermentation in a few hours in the laboratory, cells of some of the species of *Saccharomycetes* growing in great abundance. In wood in process of destruction by this fungus, similar cells have been found.

The fungi so far illustrated are but a few of the species of the highest types which produce the so-called "dry rot" in timber, and the list could be extended, though the final results of all are practically similar, all requiring about the same general conditions for growth in order to destroy the timber. Besides those of the highest type, there are many other fungi, which are very destructive. The lower order of *Sphæriacei* contains some genera which are parasitic upon the trees, especially the *Sphæria;* others of its species thrive upon decorticated trees and unseasoned sawed timber, and many are associated with the decay of timber that writers have called "wet rot." The distinction from the improperly called "dry rot" is not clear, as in either kind the presence of moisture, air, and warmth combined is essential.

The mycelia of the *Sphæria* are not so abundant as those of the higher types, but the filaments are larger, stronger, and able to pierce the medullary cells of the sap-wood, destroying them and making a free entrance for air and moisture. Fig. 17 represents *Sphæria pilifera* (Fr.), as identified by Professor Charles H. Peck, and is drawn from specimens I have found abundant upon the sap-wood of the yellow pine from the South, as stated in the former paper; another form of it is sometimes found from the same locality, having smooth perithecia; this latter form is common in the white pine in Massachusetts.

The affected wood looks dark and moldy, and, upon close examination, the little beaks, about one eighth of an inch long, can be seen projecting from the wood, and, when it is dressed, will show discoloration; if dried, the further growth of the fungus is arrested, but will be resumed if the wood becomes damp. On examination with the microscope, the resin-ducts of the medullary rays (see Fig. 11) will be found filled with the dark-colored threads, spreading to the upright ducts and the wood-cells. Although the dark threads are abundant, discoloring the wood, they alone do not destroy the canals, but are aided by fermentations.

Fig. 18 shows some of the cultivated ferments I obtained from splitting open a block and touching a sterilized needle to a resin-duct destroyed by *Sphæria pilifera* (Fr.), and then inoculating a culture-tube of prepared gelatine. It will be recognized as a species of *Saccharomycetes*, but with more elliptical cells than *Saccharomycetes cervisiæ*, the yeast-plant. In wood further advanced in decay than the destruction of its resin-ducts, rounder cells have been frequently obtained by direct observation with the microscope.

Some species of the *Sphæria* played important parts, infinitesimal though they were, in inducing the fermentations which helped decay the Nicholson pavement; for in the partially decomposed white-pine blocks I find generally an abundance of the dark hypha, and, in some, the fragments of perithecia, showing it was a *Sphæria* that produced the dark filaments, and not a modification of the white mycelia of some of the higher fungi which are often found associated with it, or in other portions of the block. The decayed spots in the white cedar before described are more or less filled with the dark-colored hypha of some species of *Sphæria*.

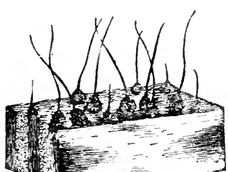

Fig. 17, $\frac{5}{1}$.

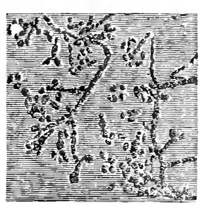

Fig. 18.

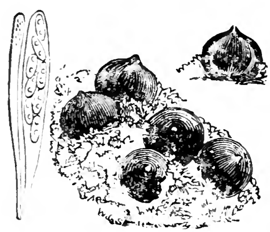

Fig. 19, $\frac{10}{1}$.

Fig. 19, magnified ten diameters, represents *Sphæria aquila* (Fr.), "Brown nestling Sphæria," very common on limbs on the ground—the mycelium pierces and discolors the wood-cells. An asci containing the ascospores, magnified fifty diameters, is shown in the left side of the figure.

Sphæria morbosa causes the black knot in plum and cherry trees.

In Fig. 20 are represented a few of the filaments and the dark

* From "Fungi: their Nature and Uses," by M. C. Cooke, M. A., LL. D., vol. xv of "International Scientific Series."

spheres in the resin-ducts and wood-cells I found in some white-pine lumber from Michigan, used for sheathing freight-cars. The wood was discolored and the medullary rays were mostly destroyed, especially those containing resin-ducts, which were penetrated from the exterior, the hypha spreading to the longitudinal resin-ducts and wood-cells; upon drying, the decay was checked, but will commence again on moisture gaining access to the wood, which is likely to be the case in the cars. Such discolored wood should be rejected for all situations where moisture will again be possible, as it will quickly decay and communicate it to other woods. I recently saw a number of window-frames made up with lumber having on a portion of sap-wood which was discolored; the dampness from the stone window-sill, after a short time, will revive the former growth in the base of the frames, and, the exterior paint retaining the moisture, the growth will be facilitated, and cause decay of the wood.

Many of the ferments I have cultivated from some of the species of wood decayed by different fungi are dissimilar in form and manner of growth; some are confined entirely to a surface-growth of the gelatine, and others germinate in small spheres along the line of inocu-

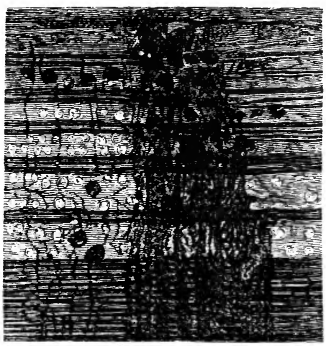

FIG. 20, $\frac{100}{1}$.

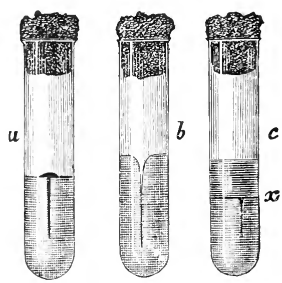

FIG. 21.—CULTURE TUBES WOOD FERMENTS. *a* shows nearly how those shown in Fig. 18 grew; *b*, those from decayed white pine; *c*, those from decayed hemlock.

lation, those nearest the surface only developing to any size, while those below the air-supply do not increase after a few days. The ferments obtained from decaying hemlock grew and liquefied the gelatine very rapidly from the surface downward; no budding ferments were found but those which grew by fission (bacteria) belonging to the *Schizomycetes*. An interesting and practical point was, that they grew rapidly in alkaline gelatine, while in that of acid they developed slowly; some cultures in the latter have not grown so much from the 1st of April to July 15th as the same kind of ferments did in alkaline gelatine in ten days after inoculation.

NOTE.—Figs. 21 and 22 are from "The Methods of Bacteriological Investigation," by Dr. F. Hueppe. New York: D. Appleton & Co., 1886.

The great abundance of germs in the air is well shown in attempting to obtain pure cultures of the ferments, as all the care and some of the methods of the pathogenic bacteriologist must be practiced. The fact of their universal presence is more readily demonstrated by growing them than can be done by the microscope alone, as one germ soon grows to a great colony, and to be seen singly may require staining to be differentiated by the microscope, so that it is likely it would have been overlooked in a specimen directly from the wood. The general dissemination of the spores of the fungi of the highest types by the wind has been mentioned; their invisibility like that of the ferments, however, eludes ordinary observation, and the bountiful supply of each, on every stick of timber, or the smallest piece of wood, is unnoticed.

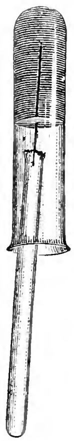

Fig. 22.—Inoculating a Culture Tube.

Fig. 23 shows the spores of *Coprinus atramentarius* (Fr.), "Inky Coprinus," magnified one hundred diameters, which just enables the engraver to define their form. Many spores are much smaller and of different shapes, while the ferments found in the hemlock require enlarging to one thousand diameters to be as distinctly seen; what the latter lack in size is made up in quantity; and this it is which enables them to set up such destructive fermentations.

When decayed timber and ties dry, and crumble to dust, some of the ferments which caused their destruction will be disseminated by the winds, and each one can form a colony; not a stick of timber in the vicinity will escape a supply; drying at ordinary temperatures does not destroy, but only renders them inactive for the time being, and harmless until surrounded by the proper conditions for their germination. When these ferments fall upon unseasoned wood which contains from thirty-five to fifty per cent of its weight of moisture, many of them germinate and set up fermentations, especially in the sap-wood, increasing their number, though their further growth may be eventually checked by seasoning; the wood, however, shows the effect in proportion to the extent of the fermentations.

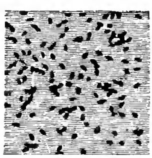

Fig. 23, $\frac{100}{1}$.

The molds play an important part, and are often associated in the decomposition of the sap or fluids in the sap-wood, extending to those of the heart-wood.

The cellulose which composes the principal part of the cell-walls of the various tissues in the wood is of itself quite indestructible, and requires some inducing cause to start its decomposition through the contained sap or moisture, which the fungi can do when warmth and air, the latter in limited quantity, are present for them to grow.

One important aid in the preservation of timber will be, for those whose duty it is to care for it, to acquire more practical knowledge of the fungi which grow on it, and this is not a difficult task. What is needed is to call the attention of the men to the conditions and to the prevention of the growth of fungi. The literature about it is meager, only foreign text-books having been published which describe the general species. Professor Charles H. Peck, in the reports of the New York State Museum of Natural History, from the twenty-third to the thirty-eighth, inclusive, has described a great many species of fungi, and has made the most important American publications to date. For practical use he has done a valuable work in the collection and mounting, in the State Herbarium, at Albany, of over twenty six hundred species, where one can in a short time learn to identify the ordinary species found upon ties and timber. In the Columbia College Herbarium there is a collection of nearly three thousand species of the general fungi of this vicinity, which is also open for study. The facilities for taking up the practical work are abundant. Every railway company has men of sufficient aptitude to learn to identify species and study their conditions of growth, and form from, the materials which can be found upon every mile of their lines, collections of decayed wood, from which the employés can gain knowledge to be put into daily practice to check much of the unnecessary decay of all their wood-work of ties, bridges, cars, and buildings.

The cheapest operation to protect our woods, and quite sufficient for many purposes, is to season or thoroughly dry the timber, reducing the contained moisture from eight to twelve per cent of the weight of the wood; and when in this condition, with a circulation of air around it, to prevent the collection and absorption of moisture, the wood will last indefinitely, as the fungi can not grow in such surroundings. Every one is more or less familiar with the soundness of timber in the upper parts of buildings, while in lower parts near the foundations it is often decayed on account of moisture.

In many situations, however, where timber must be used, the conditions of growth of the fungi are present, and it will decay; some species can be used which resist the attacks of the fungi for a long period, but the final result is decay unless the wood is treated by some process preventing the growth of the fungi, which must be capable of doing either one of two things: 1. It must keep the fibers dry, preventing the absorption of moisture. 2. If the wood must be in a damp place and kept moist, some antiseptic must be present, sufficient to prevent the growth of any of the various kinds of destructive fungi. Timber entirely submerged does not come under these considerations. To use the first process successfully means more than a thin coat of paint or tar on seasoned wood when exposed to continued moisture. It must be some substance which penetrates the tissues of the wood sufficiently far, in case the exterior surface is broken, to prevent any

absorption of moisture. Woods impregnated with the heavy tar or lighter oils are protected more from the fact of prevention of access of dampness to the fibers than by the contained antiseptics, unless in the exception of a great percentage of creosote. In the second method the moisture is permitted to come in contact with the fibers of the wood, and reliance depends upon the antiseptic. In this case, the entire wood should be saturated to give the greatest measure of success, not merely an exterior protection of a half-inch or so in depth, the latter fact, as before explained, being the cause of many of the failures which have taken place. The antiseptic treatment, to succeed, must destroy all the germs which have found lodgment in the timber, and also those which may come from the exterior.

In a general paper I can only indicate the antiseptics which have been fairly successful, though in many cases the failures were due not so much to the antiseptic used as to the faulty manner of application, which can be understood from what has been written.

The four antiseptics which are most used now are chloride of zinc, creosote, corrosive sublimate, and sulphate of copper; sulphate of iron and pyrolignite of iron may be mentioned. The treatment of the wood by bichloride of mercury (corrosive sublimate) was called kyanizing; by chloride of zinc, Burnettizing; by creosote, creosoting or the Bethel process; by sulphate of copper, Boucherie's process. Sulphate of copper has been used for over a century in preserving timber, and when well applied the results have been good. The idea of Boucherie was to force the antiseptic through all the wood-cells, which was correct, and the method successful in proportion to the extent it was accomplished.

The attempts to impregnate wood are made now with nearly all of the antiseptics, in large cylinders capable of sustaining from two hundred to three hundred pounds pressure per square inch, one end of which can be opened and closed for admission and withdrawal of the timber. When the cylinders are filled with the timber they are closed, then steam or heat is applied to vaporize the sap or moisture; after this a partial vacuum is produced and sustained for from six to twelve hours, then the moisture is withdrawn from the cylinders, and the antiseptic is pumped in and raised to a pressure of from one hundred and twenty to one hundred and fifty pounds, which is maintained for from six to twenty-four hours. Porous woods are impregnated quite readily, while the heart-wood of the yellow pine (see Fig. 1) and the white oak (Fig. 3 in August number) are not penetrated so easily, and take longer time. The external pressure may be one hundred and fifty pounds per square inch; yet the hydrostatic pressure in the cavities of the cells, not $\frac{1}{10000}$ of an inch in area, is quite small, the impregnation being to a great extent by capillary attraction and absorption through the cell-walls.

It is evident from preceding statements and illustrations that un-

treated railway-ties in the road-bed are of necessity in about as favorable conditions for the growth of the fungi as could be selected, and consequent decay is not only probable but certain and rapid. Ties of the most durable woods, as a rule, only resist decay for from eight to ten years, while inferior qualities only last from four to seven years.

The consumption of ties by our railway system will closely approximate eighty million the present year for repairs, and, as these require to be cut from special trees from thirty to sixty years old, ten to sixteen inches in diameter, will take many trees which, in as many more years, would yield from six to eight times as much timber. This rapid reduction of the prospective timber-supply is one of the serious phases of the question, and is causing grave apprehension as to the future sources of ties, not only to the railway officials, but to all persons who look to the general welfare of the country. Transportation now is so intimately connected with every business, and its cost so much a part of the price of nearly all articles, and especially of food-supplies, that the increasing cost of ties becomes a subject of national importance. The American Forestry Congress is urging the planting of trees and the better care of existing forests. While the measures it urges may help the supply of timber twenty-five or thirty years hence, they can not meet the exigencies of the case in the mean time. Railway-ties only last from one fourth to one tenth of the time required to grow them, and the forests are now being rapidly cut to furnish the supply. Very few of the railway companies are in a position to grow their ties; but, as consumers of such vast quantities of timber annually, they can take more effective measures to stop the growth of the fungi and check the enormous wastes of timber now taking place.

One important step, when storing ties and timber before using, would be to put down blocks or timbers for each end of the piles to rest upon, leaving an air-space underneath, and pile the ties an inch apart. This would permit a circulation of air and prevent the growth of mycelia, which is so frequent on the first, second, and third layers, when placed directly upon the ground. When this is not done, the fungi grow as much in the ties, in two or three months in the summer, as they would in one or two years in the road-bed.

There is one phase of decay in ties which has been generally overlooked; in fact, it would not be noticed except by making special examinations. A slight fermentation, which would only soften or make the fiber brittle under a rail or around a spike, becomes of greater importance in ties than in beams which have a large factor of safety. Ties of many species of wood, when sound, will cut under the rails to some extent, and the rate will be much increased, in case the fibers are softened or weakened by fermentations; this I found to be the fact in several hundred chestnut, oak, and yellow-pine ties which had been removed from the track, on account of abrasion under the rails, and of mechanical injury by repeated spiking. Either side of the rails

the ties were sound, and would not be called decayed. In the yellow pine the spikes check and separate the annular rings, which permits the entrance and growth of the mycelium of its special fungus, and this weakens the fiber and loosens the spike. In white oak and chestnut the layers separate by breaking through the small tracheids surrounding the ducts (see Fig. 3, August number), those of the chestnut more rapidly. The fermentations are retarded in these woods by the tannin in the cells, but they take place eventually, softening and injuring the fibers around the spikes and under the rails.

In ties which are well treated, so as to preserve them, the fermentations are held in check, and the softening of the fibers is prevented, and their durability and consequent wearing capacity are increased. This is an advantage so important that its full benefits can not be appreciated until actual comparisons are made between treated and untreated ties under similar conditions of service. I have parts of treated ties of over thirty years' service under heavy traffic, trebling their ordinary life, while there are numerous instances in which the oak has doubled its life, and the hemlock has given from five to six times its usual service.

The durability of well-treated ties is well established in this country by considerable experience on various railways. In England, France, and Germany the experience is ample, the ties lasting there longer than we can expect them to last here, from the fact that chairs are generally used to hold the rail and distribute the weight to a greater area of wood than is the case with the base of our rails; and, besides, the tonnage per car-wheel is less than ours. It is our freight-cars, with limited spring action, which cause a large portion of the abrasion of the ties. The economy would be great that would result to the railways by prolonging the life of their ties by treatment; this fact was realized long since, but in putting it into practice the information and experience were not sufficient to enable their engineers to secure the anticipated beneficial results. In fact, much of the treatment hastened the decay of the ties and timber, or, when overdone, destroyed their strength. This need be the case no longer, for the study of many of these failures has given much of the information needed, and the experience in treating wood is now extensive. The cheaper grades, such as the beeches, maples, birches, elms, and hemlocks, having a structure sufficient to sustain a heavy traffic, can be treated and substituted at less expense than the first cost of untreated white oak or yellow pine, and have a greater durability. This would effect an immediate economy in the renewal of ties.

It would be decided economy to treat the higher-priced ties, so as to double their durability. A general example is given of a mile of track on a trunk line, where 2,800 ties are used per mile: This year the ties cost fifty-five cents apiece; to lay them in the track costs fifteen cents more, and their average life will be seven years. To treat these ties

would add twenty cents to the above cost, and give them an average durability of fourteen years.

Twenty-eight hundred ties at seventy cents = $1,960, which would be the cost for seven years, and, for fourteen years, twice this = $3,920. Twenty-eight hundred ties at ninety cents = $2,520, and these would last fourteen years.

The difference in first cost is $560, and the simple interest on this at five per cent for fourteen years is $392, and this added to the $2,520 makes $2,912, a difference of $1,008 for the treated ties per mile for fourteen years. Local conditions would vary the results, but not the principle.

In the present extensive use of timber and lumber, only the roughest approximate estimate is possible of the annual loss by fungi; and the amount of loss can be indicated in only a few items. The cost of replacing decayed ties by the railways of the United States for 1885 exceeded $30,000,000. Repairs of station-buildings and road-crossings, $19,500,000. Repairs of wooden and wood parts of bridges, $6,250,000 (estimated). Repairs of freight-cars, $22,500,000 (estimated). Repairs of passenger-cars, $7,500,000 (estimated). The renewal of telegraph poles and fixtures on 160,000 miles of line constitutes a large item. The loss to the agricultural interests is much greater. The tenth census reports the cost of fencing in 1879 at $77,763,473, the most of which was for repairs. The loss caused by fungi on the 9,000,000 dwellings, with their accompanying buildings, and the $406,520,055 worth of agricultural implements which appear in the census reports, and that on the 6,654,997 tons of marine, and on wharves above water, form other large items. The lumber interests are also a great loser through the quantities of timber that are destroyed in store. The mere mention of these facts makes it evident that the regular annual loss from this source must be rated at many million dollars.

IN THE LION COUNTRY.

By PARKER GILLMORE.

THE majority of people have possessed pets of some description or other, but few are able to say that they have owned a couple of tame lions, for tame they were when I owned Leo and Juno, and I can vouch that more interesting pets were never the property of any individual. How I became their possessor I will endeavor to the best of my ability to inform my readers.

In those happy days, now some years past, when war had not broken out between the Boers of the Transvaal and Great Britain, I was hunting large game to the north of the Crocodile River, where the country of Lubengulo, King of the Matebeles, abuts on that of Kama, King of

Bamangwatos. The margin of the Crocodile River here is covered with thick timber or dense masses of reeds, but, as you retire a mile from the above-named water-course, bush-veldt becomes the dominant feature of the landscape, and is the haunt of innumerable species of the larger descriptions of African antelope. This may well be accepted when I state that from my wagon-box I have seen, at break of day, hartebeeste, wildebeeste, eland, and sassabi within easy rifle range of my position. Moreover, buffalo, quagga (the favorite food of lions), and giraffe were far from scarce in this vicinity. Thus it is not to be wondered at that the king of beasts should be found numerous where there was to be obtained such an abundance of his favorite food, while water and shelter, two necessaries to his existence, were ever close at hand.

Nightly we had heard for nearly a month the deep-muttered growl or awful roar of the monarch of the waste, but, the weather being fine and the nights clear, had little dread of his attacking either my bullocks or horses. Another protection I possessed against lions intruding themselves into my camp was, that with me were a troop of dogs of such excellence as had seldom been seen in an African hunter's camp. Several of these dogs had been imported, and great care was taken in their selection that strength and courage was their *sine qua non*, as they were to be my companions in a very distant journey.

The other dogs that completed the pack had been procured from the colony, and therefore had considerable experience in the pursuit of the smaller varieties of buck, as well as an occasional encounter with some of the larger members of the cat family, such as leopards, caracals, etc., for these species of the *feræ naturæ* still are to be found in considerable abundance south of the Orange River. The morning previous to the occurrence of the incident to which I owe the obtaining of my two pets, Leo and Juno, broke with such an appearance of bad weather that, by the advice of my servants, I determined to shift my camping-place to more elevated and, therefore, drier ground. A ridge, thickly covered with *mapini* brush, and here and there studded with meruli and mimosa trees, was selected for our new encampment, and, as the distance to it was not over six miles, it was not deemed necessary to inspan the bullocks till three hours after noon. Although the weather had threatened since sunrise, the rain kept off until we had completed about half our journey, when, as is not unusual in tropical climates, commenced one of those down-pours that have to be experienced to be appreciated. But this was not all ; with the rain came thunder, and with the thunder, lightning, of which it would be difficult to say whether the awe-inspiring voice of the one was more terrible to listen to than the sight of the brilliant, rapidly repeated flashes of the other. Bullocks can not *trek* with wet yokes, or their shoulders become galled ; thus I had to call a halt, although no shelter was near to shield us from the warring elements. I have witnessed thunder-storms in the

Rocky Mountains, West Indies, and Malay Archipelago, but never have I witnessed them so terrific as in the interior of South Africa; certain am I that in no other part of the world are they so dangerous. And the whole animal creation seems to be well aware of this; for whether it be the Caffre or the ox, the elephant or the giraffe, all equally appear to dread the tempest's violence, and become for the time being so prostrated with fear as to remain awe-stricken on the spot where they have been overtaken, without one thought of seeking shelter. Having upward of a couple of hundred-weight of gunpowder in my wagon, to have it struck by the electric fluid would have been certain destruction to all my belongings, so I took the only precaution in my power, viz., to unfasten the chain, *trek-tow*, from the dissel-boom, so that that important portion of my gear should not act as a conductor to the inflammable part of my load. In proportion to the violence of these hurricanes, so short is their duration; thus in an hour the storm had passed to leeward, and naught remained to indicate its visit, save an occasional distant flash of lightning and the muttered deep intonation of the retreating thunder. Soon the cattle were again made fast to the wagon, and with hurried steps we pursued the remainder of our journey. No doubt we rejoiced that the storm had passed; but, if I and my Caffres did so, every creature imbued with life appeared to do likewise. Thus the francolins and korans, which had formerly been silent, now piped and chattered from every ant-heap; while the gorgeous bee-eaters, sugar-birds, brilliant orioles and sociable grossbeaks disported themselves in every direction. Even the grasshoppers and lizards had found a voice, and with it seemed to thank the Creator of the Universe that the danger had now passed. Of course, after the rain the *trek* was heavy, but fat and young bullocks, with a light load behind them, soon traversed the intermediate space to our new camping-ground.

In a well-organized hunting expedition every member of it has his allotted task to perform; thus some are employed in cutting thorn-bushes to make the cattle-kraal, while others gather fuel for the night-fires, or assist the cook in preparing the evening meal. Where we had halted timber was not abundant, and what we obtained there was so saturated with the late rain that it was not without considerable difficulty a fire could be made from it. As the sky had become clear and bright, master as well as man anticipated a dry night; but, as the sun went down, dark opaque clouds commenced rising to the eastward, which gradually shut up the face of the heavens, causing the surroundings to be involved in inky darkness. The wind now began to rise in oft-repeated fitful gusts, driving with it sheets of penetrating rain that made even the interior of my wagon far from comfortable. It might have been eight o'clock or thereabout when my Bechuana hunter reported to me that the bullocks were exceedingly uneasy in their kraal, adding further, "Baas! there are lions about, and, as the

fence round them is not strong, I think you had better tie the bullocks up to their yokes." Advice from such a source was not to be disregarded, for this man had spent all his life among the wild beasts of interior Africa, and knew their habits and haunts as well as we do those of any of our domestic animals. Thus, after much trouble, and with the assistance of my lanterns, the bullocks were removed from the kraal and made fast to their respective yokes, while the end of the *trek-tow* farthest from the wagon was firmly secured to a tree by the aid of a green *rheim*, the brake on the after-wheels being firmly jammed down. Having taken these precautions, William bade me good-night and turned in among his companions under my desert house. The poet says, "Coming events cast their shadows before." Some feeling of this kind must have actuated me, for I had an intuitive perception that, before daybreak made its appearance, some misfortune or other would occur. Again and again I filled my pipe, and almost as often took my rifles from their rack, to assure myself that their breeches were not under the drip that came from many a rent in the tilt. I tried to read, but, although I had that wonderfully entertaining work, "The Woman in White," I could not concentrate my mind upon it.

Twice I had gone forth and added fuel to the far from brilliant watch-fires, and while doing so did not fail to observe that none of the bullocks had lain down, but with anxious, distended eyes gazed earnestly up to windward. *Trek* oxen are, without exception, obtsinate, perverse creatures, sometimes taking alarm where nothing is to be dreaded, at other times not taking the slightest precaution to avoid danger where it must have been obvious to them. So, seeing nothing, hearing nothing, I retook myself to my shelter. I had about finished another pipe, when a sudden prolonged pull upon the *trek-tow* so violently shook my domicile that, if proper precautions had not been taken, it doubtless would have been overturned. At this moment my Bechuana boy placed his head under the curtain of the tilt, and in smothered words told me that he knew there were lions round us. Not doubting the truth of his statement, I professed to disbelieve it, for, said I, "Why don't the dogs challenge them? Where are the lazy curs?"

William—for that was my boy's name—promptly answered: "If one or two lions here, dogs bark; but I think that there are seven or eight, and that they are scattered round about us, so that dogs are afraid to go into the bush." Scarcely had my boy done speaking when I thought that the wagon must really go over, for the horses that were tied to the sheltered side of it commenced to pull and jerk their halters with such violence as several times to raise the weather-wheels an inch or two off the ground. As nothing so reassures these animals, when alarmed, as the human voice, I got out of my domicile and stood at their heads and talked to them in such kindly language

as they were conversant with; in the mean time ordering all my attendants from under the wagon, directing them at the same time to pile on more fuel so as to make a blaze as soon as possible.

Dark as the night was, all were busy around the little encampment, if I except the dogs, who seemed to be possessed of such timidity that neither words nor blows could drive them out from the shelter they had taken between the wheels. For some minutes all had become quiet, and I commenced to hope that it had been a false alarm, when a roar so loud and close as to awake the echoes of the surrounding koppies broke the monotonous stillness of the night. Such a roar I have never heard previously or since; let him that likes say what he may, it made the earth tremble. To the reader it may appear impossible that any animal can produce a volume of sound that almost rivals the thunder in its density; but let me assure him, if he has heard a mature male lion, in the full vigor of his life, give utterance to his wrath, he will agree with me that there are a sublimity and grandeur in the voice, which, if they do not equal the depth and power of thunder, very nearly approaches to it.

If quiet had comparatively reigned before, now all was excitement. To and fro the bullocks rushed, trying to break their *rheims*, the horses reared and pulled upon their halters as if determined to strangle themselves, or upset the wagon, while every native who was not armed seized a fire-brand and shouted and called to my animals to endeavor to still their fears. So intense was the darkness that nothing could be seen, yet William fired a couple of shots in the direction from which he imagined the sound proceeded. The blaze and report of his heavy elephant gun, one would imagine, would have driven off anything in the form of a quadruped; but not so: the lion roared again at even shorter distance than at first, causing the bullocks to become frantic with fear, and therefore to use their utmost power and strength to break loose.

I thought I could trust my *rheims*, but alas! I was in error, for one more violent struggle than had previously been made took place, and they gave way, and the whole team went down to leeward as if they were stampeding before a forest fire. As the method (for it certainly is a preconcerted and arranged plan) adopted by lions when about to attack a span of cattle may not be known generally, I will briefly attempt to describe it. Lions, as a rule, hunt in family parties. A very old male, not unfrequently incapacitated from taking an active part in pursuing game, is generally to be found at the head of this *coterie*, and on him devolves no unimportant part of the programme adopted by them when a trader's or traveler's cattle are resolved upon as the victims of their ferocity and power.

Down to leeward, a hundred or more paces below where the bullocks are made fast, the young, active males and lionesses place themselves behind what available cover is to be found. This being done,

the aged manikin goes to windward of the encampment and shakes out his abundant mane in the breeze, so that the effluvia from it may be carried down to the excited draught animals. One sniff of the tainted breeze in a moment brings every ox to its feet; when standing, often trembling with fear, they gaze with dilated eyes into the impenetrable darkness. Closer and closer approaches the aged lion to his victims, shaking and reshaking the tawny dense covering of his fore-quarters; then, if the traveler's *rheims* be not strong, he may look out for a stampede; but should they hold, the aggressor, as a climax to his former manœuvre, gives utterance to his deepest and loudest roar, when the frightened beasts, if not secured by the stoutest fastenings that can be obtained, will break off and rush with inconceivable rapidity into the very jaws of their foes secreted to leeward.

Such was the plan adopted on the occasion of which I speak, and the result was the loss of three of my best *trek* bullocks. However, I had one satisfaction: as the patriarch followed on their heels, assisted by the light from our now blazing fires, I was enabled to place a pair of ten-to-the-pound bullets through his tawny hide. This I was certain of, for I heard distinctly the thud, that never to-be-forgotten and tell-tale sound of success that quickly responded to the delivery of each shot. My performance in marksmanship was not wonderful, for the object I fired upon was large, and within fifteen paces of where I stood. The foe nevertheless did not drop in his tracks, but continued his course, evidently intending to join his relatives and participate in the now provided banquet of newly slaughtered beef. But man proposes, God disposes, for many an ominous growl of pain distinctly told that the old marauder was not in a frame of mind or body to enjoy the feast. The night was so intensely dark that it would have been utter madness to have risked my life or any of my people's to drive the lions from their prey, so we satisfied ourselves by piling on fresh fuel and firing an occasional shot in the direction in which we knew the feast was taking place.

With the break of day the troop had departed, leaving behind them nothing but a quantity of scattered bones, half a dozen hyenas, and as many jackals to tell of the tragedy which had occurred but a few hours before. Soon the unclean brutes followed the example of their betters and skulked off in various directions, doubtless with the intention of returning when the camp was deserted, or as soon as night again placed her impenetrable seal of obscurity upon the landscape.

On inspecting the locality where the disaster had taken place, an indentation in the ground was discovered, where several pools of coagulated blood were found, the soil around them scratched up and tufts of grass torn by their roots from the ground scattered about, while the only spoor in the immediate vicinity was that unquestionably of the old warrior on whom I had opened fire. William took up his trail, and, at the distance of half a mile, our foe was detected under

the shelter of a mapini-bush. Poor brute, it was evident that he was sick unto death ; still, his heart was willing for the fight, though his body was weak in power to assist him. On perceiving our advance, with a determined effort, he gained his legs and faced us, his countenance as plainly as language spoken showing that surrender without a final effort was not intended.

I fear I was prompted by too many feelings of revenge to appreciate the noble sight the discomfited foe presented ; for what wonder? Had I not lost three of my best draught-cattle ?—a loss the magnitude of which can scarcely be understood except by those who have been placed in similar positions. The gallant beast's head was down, his lips curled upward, so as to show his formidable tusks, while his tail, as stiff and straight as a crow-bar, was erected aloft. If he had possessed the power now, he would have charged ; as it was, he remained as splendid a target as the most fastidious could desire. I aimed between his eyes, and, ere the smoke had drifted away from the muzzle of my smooth-bore, the hero lay extended at length upon the sparsely covered veldt. While admiring my prize, three Makalakas approached me ; the grin upon their countenances showed that they had something unusual to tell, or else something to dispose of. I was not long detained in doubt which it was ; for from under a kaross two of their number produced each a lion cub, about the size of a six-months-old kitten. While admiring the little beauties, who seemed in no way to feel the awkwardness of the position, a roar was heard in the distance, which caused the Makalakas to pick up their treasures and rapidly gain a position behind William and myself. "By gum," exclaimed William, "here comes ma !" and scarcely had he delivered his brief assertion than her ladyship made her appearance, trotting hastily toward us. When seventy or eighty yards off, she halted and uttered a suppressed growl, different in intonation from any that I had ever heard emanate from any of her family. Up to this time the little wee beasties had been models of propriety, but the voice of their dam had in a moment transformed them into fiends incarnate, for they scratched and bit their possessors with such determination and energy, at the same time squealing, that the Makalakas were fain to drop them on the ground, the better to enable them to retain possession of them. The three natives had a busy time of it in accomplishing their purpose, but William and I had other and more important matters to attend to, for, the moment the lioness heard the screams of her offspring, open mouthed and almost flying with velocity she charged upon us.

My first shot staggered her and brought her to the ground, but in an instant she regained her feet, and, nothing daunted by the check she had received, continued her headlong course. Again I pulled the trigger, and down she fell, her shoulder smashed, for her left fore-leg dangled and doubled under her as if deprived of joints ; but a three-

legged lioness is not incapable of doing mischief, and so William thought, for at only a few paces he administered the *coup de grace*, aimed in the region of the ear, which put a favorable termination to a short but very exciting scene.

My new acquaintances, I learned, were herdsmen of Lubengulo, King of the Matebeles, who, when driving their cattle up, to kraal them for the night, disturbed a lioness; a Bushman who was with them fired at her a poisoned arrow, which, it was believed, had taken effect. As a scratch from one of these pygmy weapons is almost certain to produce death in a few hours, my new friends had gone at break of day to search for their anticipated prey, but, losing the trail and making sundry efforts to regain it, they unexpectedly discovered the youngsters in a hole scooped in the bank of a dry water-course, which they at once secured.

Fortunately, they encountered us when they did, or *Madame la Mère* would have made them regret their temerity. On examining the lioness, no indication that she had been struck by the arrow of the Bushman was to be seen; either the bowman had missed her or this was not the animal he had shot at. A couple of pounds of gunpowder and four bars of lead were treasures too valuable for natives to refuse, so Leo and Juno became my property. The herdsmen, not satisfied with the discovery that the killed lioness was not wounded with the Bushman's arrow, renewed their search, and in the course of the day, on their return to their kraals, passed my encampment bearing a newly taken hide, satisfactory evidence of the rapid and fearful certainty of the virus with which they anoint the points of their diminutive weapons.

There are several poisons in use among the aboriginal tribes of Southern Africa, but that extracted from a caterpillar, and designated by the natives "mangue," is the most fatal. The pain which the victims suffer who have been inoculated with it must be fearful indeed; but it is not long endured, for two or three hours generally put an end to the stricken animal's existence. Of course, this time is more or less protracted by the size of the wound, the locality in which it is situated, and the quantity of the venom used; for instance, on one of the tributaries of the Zambesi, a lioness that had been wounded at sundown did not expire till the following daybreak, during all which time the cries of anguish that she kept repeating, terribly told how fearfully the poor creature was suffering. On examination, this victim of the poisoned arrow only had a slight puncture beneath the skin close to the flank, but the firmness of the hide had prevented the missile from falling from the wound.

As the habits of semi-barbarous people always possess great interest for me, I trust they do so for my readers, and I will therefore describe the two other poisons in use among the Bush-people, and the manner in which they are employed to serve their purpose. First, I will ad-

vert to the juice of the euphorbia. This is a family of plants all alike foreign to the European eye in appearance, although not by any means strictly tropical. Some species possess much more poisonous matter than others, the most deadly being in appearance like a crooked pole with a bunch of long, hard leaves decorating its summit. When employed by the natives for the purpose above spoken of, it is collected in quantities on the margin of a small vley or pond of water, when it is beaten between stones till the necessary quantity of the juice impregnates the water. At night unconscious game, probably thirsting from the hours they have passed in the sun-dried desert, come to the vley to satisfy their craving for drink, but scarcely have they done so when they become intoxicated, and soon after lie down to sleep the sleep that knows no waking. In this death I do not think the victims suffer much pain, for all that I have seen that have been killed in this manner were in the positions they would assume if they had laid down to take their natural sleep.

It is strange that this poison is much more injurious to horses, zebras, and quaggas, than it is to cloven-hoofed or horned animals. Why I state this is that while the former will not proceed over half a mile after they have imbibed the subtile fluid before being incapacitated from going farther, the latter will travel many miles ere they drop, if drop they do, for I am convinced that many escape death from this poison, although possibly brought very close to it.

To carnivorous animals, such as lions, leopards, hyenas, dogs, etc., it does not produce death, only stupefies them for the time being ; at least, such was my observation in reference to my dogs, when I knew that they had drunk a quantity of the diluted water. It is to be regretted that the natives should use such a means to secure game, for I know of a whole herd, amounting to over fifty zebras, perishing in one night, although the requirements of the few inhabitants of the district would have been amply supplied by a couple of carcasses, for it must be remembered that in these regions decomposition sets in very rapidly after life becomes extinct.

The third poison used by these most interesting natives, the Bushmen, is that taken from the glands of the Mamba cobra, or puff-adder, with which the points of their arrows are thickly coated. Exposure appears to weaken these reptiles' virus, for, previous to any important hunt taking place, the barbs of the tiny weapons receive a fresh dressing of the baneful fluid. Game killed by all the above methods is eaten by the human family, or carnivora, without producing any evil effects.—*Land and Water.*

SOME OUTLINES FROM THE HISTORY OF EDUCATION.

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I.

IT is noticeable that, upon the subjects of education and religion, almost every one believes he has something to say. It is noticeable also that this belief is often quite apart from knowledge or special preparation. In mathematics, we wait for the judgment of the mathematician, in chemistry, for the judgment of the chemist, while in education we wait for no one, but bring forth our opinions loudly and dogmatically. We have, as a pleasant consequence, the fact that the nonsense written and spoken about education is like no other nonsense for completeness, except that written and spoken concerning religion. What fledgling does not think it in his power to produce a helpful tractate about God, his nature and *modus operandi?* In like manner, who can not write a *scientific* tractate upon education?

It is a consideration of much moment, when approaching such a subject as education, to reflect that true science ends controversy. The Ptolemaic and Copernican systems may not share the heavens between them. Is it said we have various systems of theology? This is painfully true, the reason being that we have not a scientifically adequate one on the face of the earth. The same is the case with systems of government and political economy. We may safely conclude that the fact of the existence of diverse systems is proof that the given subject has not been reduced to scientific expression.

From earliest times there have been teachers and students; from earliest times great-minded men have given themselves to the work of education. We see throughout Europe ancient seats of learning cared for by governments and reverently regarded. More than this, during the past two, even three centuries, enthusiastic efforts have been made to found education upon its true bases. Most fitting opportunities were granted to men who thought they had the science of the matter; experiment after experiment was tried; and yet to-day we find ourselves in the very thick of the conflict, on the threshold of great changes, and apparently no nearer the education-science. Naturally the question arises, Why is this so? as naturally also the further question, What have we to expect? These inquiries are vitally related, and the answer to the second follows from the answer to the first.

Past endeavors have not given us a science of education because, from the nature of the case, education is the last subject that can become a science. Who is it whom we seek to educate? Man. What

is man? Evidently if we are to educate man upon scientific methods we must know what man is; we must know the laws of his being, the relation of these laws to one another, and to the end for which man is made. The science of education, therefore, presupposes a true psychology, and a knowledge of the formation of character based upon this psychology. In our country so-called educational treatises are written by persons who have neither psychology nor minds to comprehend it; and, while these works may have much valuable practical matter, they should not be received as in any sense scientific. With one exception ("Education," by Herbert Spencer), the only works which may claim to pretend to treat education scientifically are German, and every one of these bases itself directly upon some psychological system. I need but name in illustration A. H. Niemeyer's "Ground Principles of Education," Fred. Schwarz's "Instruction-Book of Pädagogik," as coming directly out of the Kantian thought, or Miss Anna C. Brackett's translation of "The Philosophy of Education," by Professor Rosenkranz, the biographer of Hegel, as an application of Hegelian thought to education. We of to-day are feeling the influence of an entirely different philosophical system from either of those above mentioned. Our educational methods are being remarkably and rapidly modified. This change has received its psychological expression in England, and Mr. Spencer may be regarded as the representative thinker of this new school. Here the idea of man as to his nature and the laws of his development is distinct and peculiar; it gives us an education based almost entirely upon instruction in the physical sciences.

Pending the attainment of a psychology that shall secure sufficient general recognition to become the source of proper reform in our educational efforts, it would seem that nothing could be more profitable than some consideration of the history of education. It is surely matter for regret that a subject so important as this should not long since have been examined in the light of the idea of development. It is our good fortune in most other matters to have abandoned *a priori* discussion. Even with so deep a work as Goethe's "Faust" we feel that it is necessary to proceed historically if we are to gain correct ideas as to its origin and meaning. We have come to recognize this "Faust" as the life-poem of one of the greatest of our race; we have come also to know that the material which Goethe transformed was deeply rooted in our common humanity, and had already passed through a natural and vigorous development long before the poet's day. How much profundity of nonsense this historical feeling would have saved us in literature and religion can not be estimated. Our debt to Comte as the living source of modern historical feeling may well temper our judgments before his later speculations. We have a right to expect that whatever value there is in general historical study, as related to the life and works of men, we should find in the history of education

as related to the practical matter of teaching and learning. There is even a closer relation between general history and the history of education. This is seen in a moment if we consider again who is to receive the education. The ideas which man has entertained about himself have determined alike his history and his education. The profitable thing in considering our subject historically is exactly this detection of man's ideas of himself. We see these ideas shaped by varying circumstances, and in turn shaping man's activity in every direction. Education has had a wonderful unfolding and there is not a phase of its course which may not be traced to that idea of man's nature and destiny which prevailed at the time.

This close relation between general history and the history of education has led to the adoption of the same broad time-divisions in both subjects, as follows:

Before Christ.

From Christ to the Reformation.

From the Reformation to Pestalozzi.

From Pestalozzi to the present.

This division is the one chosen by all authorities in the history of education, though special reference may here be made to Schmidt's "Geschichte der Pädagogik," a work of remarkable philosophic value, and one to which I am greatly indebted in the preparation of these articles.

Turning to the first division, we find that the nations having a history and corresponding systems of education are the Chinese, the Indians, the Persians, the Egyptians, the Hebrews, the Greeks, and the Romans. Nothing can be more interesting and profitable than to observe how directly and completely the education found among these peoples was shaped by the ideas which they respectively entertained about their own nature and destiny.

We have frequently been asked to consider the peculiar appearance which China presents in history. There is something here as sad as it is peculiar. Centuries before the nations of to-day had emerged from barbarism, China showed remarkable advancement in civilization. We should not think here chiefly of the public works constructed by this people, such as the wall of defense or the canal, or even of their knowledge in special directions, such as the use of gunpowder or the art of multiplying impressions from woodcuts, or the use of porcelain, the compass, and the bell. The fact above all others to be noted is, that in no country, without exception, has such direct and supreme value been placed upon education as in China. The educated man alone could hold office in this vast empire; riches and birth were of no avail if the man were uneducated. We may contrast this profitably, so far as the idea is concerned, with our American suffrage system, where the vote of bestial ignorance counts for more than that of trained intelligence, and where *the* qualification for office is availa-

bility. In China, the higher the office to be filled, the higher must be the education. Such being the estimate placed upon education by this people, we should not judge that stagnation would prevail in China for over twenty-five hundred years and education become nothing but pitiable mummery. We learn a valuable lesson here as to the way in which one fundamental error can vitiate centuries of national existence. China, as arrested development, has been aptly compared to the feet of her women.

In seeking the cause for such arrest of growth, we come upon the idea which this people entertained of themselves : they were members of a family—nothing more ; the emperor was their father. This family-idea, applied everywhere and never transcended, kept the people children. With our modern feeling of individuality so fiercely coursing in our veins, we find it almost impossible to realize that in China there were no *persons*, no individuals. A human being fully grown, and with what should have been the strength of manhood upon him, was simply a son, a child. He did not belong to himself or to a nation, but to a family. Absolute obedience to father and teacher prevented all progress beyond the condition of father and teacher : learning was ceaseless repetition. The Chinese had village schools, town schools, and universities ; their highest reverence was for the most learned, and their education found its supreme test in an act of memory.

Passing from China to India, we find that man's idea of himself is somewhat enlarged. The people are divided into four castes : Brahmans, warriors, merchants, Sutras. Birth determines each man's condition and duties ; to be a Brahman is to live and die a Brahman, to be born a Sutra is to live and die a Sutra. No physical law is more inflexible than the law of caste in this far-off land. But these social divisions show improvement over the condition in China. Man is nearer himself as member of a caste than as member of an enormous family. Further, man in India has been shaped by a most wonderful religion. The special mental characteristic of the Indian, imagination, fancy, was constantly and powerfully influenced by the outside world. Nature seemed to have produced one impression above all others upon the Indian mind, the impression of universal necessity. We find these elements at work determining the idea which man had of himself and molding the education of India. The Sutras were so low as to be beneath all education ; the other classes were trained for their special duties—the Brahmans in religion, the rulers and warriors in government and war, the merchants in trading. As there might be members of the higher castes in villages, provision was made for their instruction by elementary schools. This instruction consisted in reading, writing, and reckoning. A teacher, with staff in hand, would take his place under a tree and teach the boys sitting around him. In arithmetic only the rudiments were taught. Writing was

closely connected with reading, and was taught by a stick in the sand; then on palm-leaves with an iron point, and at last on plantain-leaves with a kind of ink. In the higher schools at Benares, the *exoterics* (which might include members of the second and third classes) were taught grammar, prosody, and mathematics; the *esoterics*, poetry, history, philosophy, astronomy, medicine, and law. The pupil is a listener for five years; then he is allowed to take part in the discussions. The period of study lasts from twelve to twenty years, and the highest instruction is furnished by a study of the Vedas. Though the Indians had no theory of education, they expressed wise educational maxims most beautifully by fable and poetry. "War-skill and learning are both renowned, but the first turns to folly in old age, while the second appears worthy for every period of life." "Culture is higher than beauty and concealed treasure, it accompanies you upon your journeys through foreign lands and gives an indestructible power." "As the tree shadows him who would cut it down, and as the moon illumines the huts of the lowest, so should a man love those that hate him." "Be humble, for the tender grass bows itself uninjured to the wind, while mighty trees are rent in pieces by it." "The wise man should strive to attain knowledge as though he were not subject to death, but he should fulfill the duties of religion as though death were settling upon his lips."

Did the special purpose of the present paper allow, it would be instructive at this point to notice the reformation in the religion of India. Brahm and Nirwana as root-ideas appear to have been essentially the same, and the highest glory of man was absorption in the *all*. That which is especially instructive here is the fundamentally different development of this common idea in Brahminism and Buddhism. For the Brahman, God is in everything: everything *is* God; from this come the deification of Nature and all forms of animal-worship.

For the Buddhist, on the contrary, since the highest blessing is the loss of one's self in Nirwana, everything that has independent existence must be cursed by the very fact of existence. We must pity, not worship, anything that *is*. From this interpretation of the common idea, what are wealth and social distinctions? Where *all* is wretched, how can one thing be better than another? Buddha, well called the Luther of India, could cut clean through the caste-distinctions and make a way for what, long afterward and under other influences, so mightily prevailed in Christendom, the conventual system, the order of monks.

Buddhist education was training in Buddhist religion. The principles of this education are found in the catechism of the Buddhists, and take the form of such commandments as these: "Thou shalt not steal. Thou shalt commit no act of impurity. Thou shalt do no wrong by thy speech. Thou shalt drink nothing intoxicating. Thou shalt not kill any living being."

Among the remaining Oriental nations we find ideas respecting man that are equally narrow and ill-adapted for advancement. In Persia the national idea, in Egypt the priestly idea, among the Israelites the patriarchal idea, determined respectively all that was undertaken in the way of training. It is a singularly instructive fact that man, as an individual, first appears among the Greeks and Romans. Here lies the radical difference between the contributions to history offered by the Eastern peoples and that progressive movement commenced at Greece and Rome. The trite saying, "History began with the Greeks," finds its philosophy in the fact that here man entered on his career as an individual, a person. This idea of individuality, however, was by no means unlimited. It never exceeded the boundaries of Greece and Rome. A Grecian was a person, a Roman was a person; for them there were rights and opportunities. They could be educated. Man *as man*, however, was not yet known. Despite this serious limitation we must call the advance shown by these peoples great when compared with all that had preceded. To say I am an individual Grecian, an individual Roman, is far better than to say I am a child among millions of other children, or, I am a member of a caste. It has been frequently observed that education among the Greeks and Romans shaped itself in strict keeping with the root-difference between these peoples. For the Greeks, highest excellence was *beauty*, in body and mind; for the Romans, it was *result*, something brought to pass, whether physical or mental. Therefore the Greeks surpassed in art and philosophy, the Romans in war and law. It has been often remarked that our first theoretical treatment of education is furnished by the Greeks. Plato, in his "Republic" and "Book of the Laws," states the fundamental principles of education, and surrenders the individual to the state. Education is an affair of the state and for the state. Here is the limitation of individuality, a limitation not to be exceeded at this time by this people. The Romans, not demanding public education, left the child to home training for his earlier years, but placed him as a youth with some celebrated jurist for special instruction in law and state-craft. This Roman training was, from beginning to end, *practical*, and never lost such character even after the rhetoric and philosophy of Greece were added to the subject-matter of education.

Human history, and consequently education, were now to feel the impulse of a new movement. Christianity, whether true or false, appears with the announcement that "God hath made of one every nation of men for to dwell on all the face of the earth." In this is contained a truth that gave Christianity power to supplant heathenism and to shape the course of education for centuries. The history of education for a long time after Christ would be a history of the Church. We need concern ourselves with this movement only so far as to find a thread of development that may lead from past times to

the present. Persecution was the inevitable experience of those who allied themselves to the new faith. During the earlier years the struggle for existence was constant and absorbing. The children were necessarily kept at home and taught only the simple forms of the new faith, or were sent to heathen schools for instruction in reading and writing. This practice continued until persecution had relaxed its grasp sufficiently to allow some reflection upon the new religion as a body of belief and teaching. With this reflection came the supposed discovery that Christianity was something purely spiritual and heavenly, having no concern with earthly affairs. The error here, though natural, was fatal. A misunderstood Christianity led men astray and multiplied sorrow for the race. With the growth of this religion it became necessary to instruct the converts in the faith they were about to adopt. During the first century A. D., institutes for the catechumens, or schools for teaching Christianity, were established. The heathen converts were at first grown persons, and were taught nothing but the principles of the new religion: all other training they must receive from the heathen schools. Christianity was to train for heaven, not for earth. The order of the monks appeared in Palestine, Constantinople, and Rome. Education was the special care of these men, who had forsaken all worldly interests, and education consisted wholly in such instruction as would fit for the duties of the order.

With further advance Christianity began to reach out over all departments of life. Now, for the first time, leading men among the Christians demanded that the children should be taken from the heathen schools and receive all their education at the hands of Christians. That the catechetical schools made no break with heathenism is plain. Clement was a leader of these schools at Alexandria from 189 A. D. He was master of classical training, and brought his learning to the service of the new religion. He felt no pronounced opposition to heathenism, but believed it could illustrate and advance Christianity. He says, "Mosaic law and heathen philosophy do not stand in opposition to one another, but are related as parts of one truth: both prepare, but in different ways, for Christianity." The new force, however, was irresistibly working in contrary direction. A few years from the death of Clement the new religion announces its direct and uncompromising hostility to heathenism and all forms of heathen education. There was war to the death against everything connected with Greece and Rome. Education must train for heaven and for nothing else. By imperial order the schools of philosophy were closed, 529 A. D. No more were children to be suckled in a creed outworn, no more could one "have sight of Proteus rising from the sea or hear old Triton blow his wreathed horn." From the fourth to the sixth century heathen culture was trampled out by the march of the barbarians over the empire.

To estimate in any sense justly the course of events through this

formative period, it is, I think, important to recognize the elements at work in the process. The East and the West were to be dealt with by a new religion; more than this, the barbarian must be subdued; the savage conqueror from beyond the Alps must be trained. As has been said, it would prove far more difficult to adjust philosophies and old religions to the new faith than to convert and baptize the rough, fresh peoples who were but just coming to self-consciousness, and whose vigor would furnish material for the world's progress. When we consider the magnitude of the problem, we shall not wonder that the day was long in dawning; we shall not wonder that Christianity went astray from the path whose direction it contained within itself. Throughout the entire middle-age period Christianity was unable to assimilate, organize the heritage of classical thought. It seemed necessary that Christianity should preserve existence and form as against Grecian philosophy and Oriental mysticism by rising above all human things, by fixing the eye on heaven.

At this time, when the treasures of the world's learning seemed lost beyond recovery, the cry is again heard, "*Ex oriente lux!*" One of the most brilliant and astounding phenomena of human history now appeared—Arabian culture.

It has been said, and perhaps too often of late, that what we regard as the deeper differences of our fellows correspond to the broad divisions of the earth. Races and peoples differentiate themselves according to climate and territory. This is taken as a clew to the proper definition of a people—viz., "a totality of individuals in the mass of humanity," a totality conditioned by the land to which they belong and by the stage of development on which they enter. It is important to remark the word *conditioned*. The distinguishing characteristics of a people do not come entirely from without. There is something more than climate and environment. This may properly be called the race-type, which, like the primal constitution of the individual, is never *created* by education; dependent on land and climate for expression, it unfolds after its own kind. The impress of the original type is found wherever the development has been sufficiently advanced to bring out the varied parts of our nature. By this is not meant that each people accomplishes something distinctive in religion and government, morals, science, and art.

Our meaning rather is that the mark of each people is plainly visible on all these manifestations. The statement is just that each people is an *individual* within the race, and that it will show the working of *three* forces—original constitution, climatic condition, influence from adjacent nations.

Our examination of any national movement can not deserve approval unless the idea of development control the investigation. We are above being satisfied by facts alone. History is alive. It is no longer enough to know that at such a time the Arabians conquered

Spain, passed on to France, were defeated by Charles Martel, ruled for centuries in Granada, lived luxuriantly, fostered literature and art, were at last driven back whence they came, and are now as nothing in the world's life. We need to discover the natural place and functions of the Arabian people in history. We must know this people as a *growth* on the common tree. Any detailed examination of the kind indicated is foreign to the purpose of this paper. While, however, nothing but the merest outline can be drawn, it should consist of living lines—i. e., of those features which represent the causes at work in this given historic unfolding. It is well understood that Arabia is physically one of the most peculiar of all countries. It seems pre-established to make tribes, to prevent nationality. Its shape is that of a triangular peninsula, limited on the west by the Red Sea, on the south by the Indian Ocean, on the east by the Persian Gulf, on the north it joins Syria. The most remarkable feature of the country is the almost impassable separation between the exterior and interior, between the coasts and the central land. This separation is made by a broad belt of desert, yet beyond the sand-wastes is the Arabia of the Arabians, the most productive and healthy portion of the entire country.

Not only is the land itself peculiar, it is peculiarly placed. Alexandria lies upon the left, Jerusalem and Damascus in front, Persia and the Orient upon the right. The remark is familiar that almost all the philosophical and religious systems of the known world would meet here in passing. We need a few sentences as to the people themselves and their condition before the appearance of Mohammed. The origin of the Arabians is lost in tradition. There is no question, however, that the division of this people into classes obtained from earliest times. There were the pure Arabs and the Mostarabs; the former lived in cities, the latter were the true sons of the desert and led always the nomadic life. Here we find the origin of the present well-known separation of the people into Ahl-Bedoo, or dwellers in the open land, and Ahl-Hadr, or dwellers in fixed localities. We find the complete expression of the nomadic Arab existence in the clan, the family. While the residents in cities show such modifications as would be expected from closer and more permanent intercourse, still here also the family, the tribe, was matter of chief consideration. Arabian land had severed the Arabian people at the same time it had developed immense physical endurance.

We need some characterization of the Arabian nature, that individual and primary constitution which, produced by no climate or circumstances, developed as external conditions might necessitate, yet always *as itself*. The Arabian nature has been said to have the following characteristics in remarkable degree and intensity: "Seriousness and pride, veracity, generosity, hospitality, passionateness and ardor in love and hatred, vindictiveness running on and on through

years to the last member of the tribe, and often mounting to extreme cruelty. Mentally the peculiarities of the people were receptiveness, quickness of discernment. They had high esteem for lyric and narrative poetry, and possessed language of perfect form suited to express the various ideas which Nature might suggest to a pastoral people, and to portray the fiercer passions of the mind." Before the time of the Prophet, Arabia had clusters of inhabitants thus endowed. There were tribes, but there was no nation. There were peoples allied to each other by a common nature, yet driven apart by an independence born of wandering life and desert solitude. Mohammed made a nation, such a nation as was possible. Unity, in the full sense of that word, never obtained among this people. Yet they were so aggregated by the Prophet as to conquer the old world, to invade Europe, to threaten Christian civilization, to hold Spain for eight hundred years, and to pass through a most brilliant career in every department of human activity. Was there nothing ready to the Prophet's hand? Was there no preparation for the message "There is one God"? It is here at such points as this that we may find chief interest in historical movements. To trace living connections between the old and the new is alike the highest intellectual gratification and truest historical exposition.

Though the Arabian people were separated into tribes, and though these tribal distinctions were deep and permanent, there were not lacking certain points of connection. Had such comings-together been entirely wanting, nothing of all that happened could have happened. Between these Arabians, whether roaming over the desert or living in cities, two forces ever tended to bring them together: the one was religious, the other artistic. Mecca had been a sacred place to every dweller in the land from earliest times. Here, in soil utterly desolate, burst forth the magic well Zem-Zem. It offered its waters to Hagar and Ishmael. It had medicinal properties and miraculous virtues; the people came together, and Mecca was built. More than this, here was a sacred black stone, mysterious in origin and power. It was said to have come from heaven with Adam. Here Adam worshiped after his expulsion from paradise, in a tent sent from heaven. Seth substituted a structure of clay and stone. This was destroyed by the deluge, and rebuilt by Abraham. As it now stands in the mosque at Mecca, it was shaped in the year 1627. It is from thirty-five to forty feet in height, eighteen paces long, and fourteen broad; its door is covered with silver, and is opened but three times each year. This is the Kaaba. In its northeast corner, incased in silver, lies the black stone, toward which all the faithful turn in prayer. So much had religion done to bind these Arabs together. There was an artistic influence. "Poetry seemed the necessary expression of the passionate nature of this people. Poetry preserved the genealogies and rights of the tribes, as also the memory of great actions. A poet honored his tribe; in turn his

tribe and kindred tribes joined to do him honor." Every year, from all parts of this strange land, there was a gathering near Mecca. The poets recited their poetry, disputing for the prize, and the assembly determined the merits of the productions. Seven poems, each the work of a distinct poet, were thought worthy of special esteem. They were written down in golden characters upon Egyptian paper, and suspended upon the walls of the Kaaba.

Only one of these poems antedates the new faith; the author was contemporaneous with the Prophet. I make two brief selections from the first poem; in the one the poet is describing his steed, in the other a storm:

"Often have I risen at early dawn, while the birds were yet in their nests, and mounted a hunter, with smooth, short hair, of a full height, and so fleet as to make captive the beasts of the forest—a bright bay steed, from whose polished back the trappings slide as drops of rain glide hastily down the slippery marble.

"Even in his weakest state he seems to boil while he runs, and the sound which he makes in his rage is like that of a bubbling caldron. When other horses are languid, he rushes on like a flood, and strikes the hard earth with a firm hoof. He has the loins of an antelope and the thighs of an ostrich; he trots like a wolf and gallops like a young fox."

THE STORM.

"O friend, seest thou the lightning, whose flashes resemble the quick glance of two hands amid clouds raised above clouds?

"I sit gazing at it—far distant is the cloud on which my eyes are fixed. Its right side seems to pour its rain on the hills of Katan, its left on the mountains of Sitar and Jadbul. The cloud unloads its freight on the desert of Ghabeit, like a merchant of Yemen alighting with his bales of rich apparel.

"The small birds of the valley warble at daybreak, as if they had taken their early draught of generous wine mixed with spice."

A verse from the poem of Tarafa:

"I consider time as a treasure decreasing every night, and that which every day diminishes soon perishes forever.

"By thy life, my friend, when Death inflicts not her wound, she resembles a camel-driver who relaxes the cord which remains twisted in his hand."

From the poem of Zohair:

"I am weary of the hard burdens which life imposes, and every man who, like me, has lived fourscore years, will assuredly be no less weary. I have seen Death herself stumble like a dim-sighted camel; but he whom she strikes falls, and he whom she misses grows old even to decrepitude.

"Whenever a man has a peculiar cast in his nature, although he supposes it concealed, it will soon be known; experience has taught me the events of this day and yesterday, but as to the events of to-morrow I confess my blindness."

A later Arabian poet says:

"No sooner do I see a learned man, than I long to prostrate myself before

him and kiss the dust of his feet. Equally valuable are the ink of the doctor and the blood of the martyr. The world is supported by four things only—the learning of the wise, the justice of the great, the prayers of the good, and the valor of the brave."

Men who could feel and utter such truths might well have something to do in the world. On the 16th of July, 622 A. D., Mohammed fled for his life from Mecca to Medina ; eighty years passed, and Syria, Persia, Northern Africa were subdued, and the Moslem host stood upon the southern coast of the straits of Gibraltar, prepared for the conquest of Spain. Mohammed made a nation.

It were most interesting to obtain a philosophical account of this man's character and career. This is not, however, in the line of our present purpose. It is sufficient here to remember that monotheism was the one lesson taught the Semitic race. The original God-idea was One Being, God over all. It is very justly remarked that, in the opinion of Mohammed, this idea had been narrowed by Judaism : God had become the God of Israel. Again, this idea had been falsely developed by Christianity in her doctrine of the Trinity, and in her anthropomorphic Saviour. Directly opposed to both of these is the proclamation of the Prophet, "There is but one God, the Living, the Ever-living, the Holy, the Self-contained, and Mohammed is his prophet."

This pure monotheism recognizes no distinctions among men ; no Jews, no Christians, no classes—God is one God. Here is the source of Mohammed's power.

Our literature is filled with testimonials to the marvelous expression which Arabian culture received in Spain. There is no need to enumerate the schools of learning or the achievements of this people in every direction. I am confident that a few words from the Arabians themselves will do more than can be accomplished in any other way, to show their attainments in thought and feeling.

In Persia the faith of Islam became a mystical pantheism ; this finds beautiful expression in the lines of Rumi, who died in the year 1262 :

"I am the little sun-dust—I am the great sun-ball ;
To the little dust I say remain, and to the sun, pass on.
I am the morning's glimmer, I am the evening's haze ;
I am the wild leaves' moaning, I am the sea's high billow ;
I am the mast, the rudder, the steersman, and the ship ;
I am the physician, the sickness, the poison, and the antidote ;
The sweet, the bitter, the honey, and the gall ;
I am the chain of Being, I am the ring of worlds."

To this all-soul humanity should make complete surrender :

"Truly death ends life's need,
Yet shudders life 'fore death ;

Life sees the dark hand,
Not the bright gift which she offers;
So shudders before love the heart
As if threatened with destruction,
For where love awakes, there dies
The I, the dark despot:
Let him die in the night,
And breathe thou free in morning red."

In the year 1060 a prince, living on the southern shores of the Caspian Sea, wrote and gave to his son a book, called the book of Kabus. This gift was to represent better things than gold and lordly station. I translate, as before, from a German rendering:

"Know, my son, that this world which God created, he created according to his purpose. He did not create it in vain, but that his justice and excellence might be known; and he adorned it with the measures of his wisdom, for he knew well that beauty is better than ugliness, and wealth than poverty; that existence is preferable to non-existence, and abundance to destitution. Obey God and serve him—this is the first commandment which man has to fulfill. At the same time also honor thy parents. He who highly esteems his kindred highly esteems himself. From whomsoever thou mayst have sprung, know this, that it is better to be renowned for virtue than for inheritance. Honor is based upon understanding and good habit, not upon birth and fortune. Speak always courteously, that you may hear courteous answers. The reply for fools is—*silence*. Guard thyself against uttering falsehood; seek to be known and celebrated for the reliability of thy word. Under all circumstances forget not God in thy youth. Since it is indispensable to the great that they should be instructed from the very foundations of every subject, and since no one can derive profit from any art before he is acquainted with the hidden mysteries of the same, so consider, at first, the highest and most excellent of all sciences, the science of religion. Religion is a tree whose root is faith in one God and whose branches are the laws; knowledge of the one and of the other secures temporal and eternal advantage. Apply yourself, therefore, my son, to the science of religion, for this is the trunk of the tree of which the other sciences are but branches."

The prince now gives advice so practical, so wise, as to be worthy of application by all sons at all times:

"My son, dost thou desire to become a preacher, remember, when thou art about to ascend the pulpit and to preach, quarrel and wrangle not with those who sit beneath. Speak everything as thou willest, only have care that all be truth and no error. Speak elegantly and fluently, and hesitate not, but speak according to thy heart's desire. From pride, deception, from a sensual life, remain free. Know this, that what of good actions thou practicest thy people will also perform.

"Dost thou desire to become a judge, then must thou be courageous, sharp-sighted, quick of comprehension, and a man of sound judgment. Thou must know what thy case has before it and behind it; thou must be a judge of men. Thou must know the habits of every class of men, thou must see into their failings. Give to each cause much investigation and, reflection, and after thou hast

discerned the right decision, express it in few words that not a syllable further be needed. Above all things must the judge be honest, and his chief excellence consists in this, that he is learned and self-controlled, and keeps himself from forbidden things. Dost thou desire to become a physician? Then must thou learn the theory and practice of medicine. Thou must investigate fire, air, water, and earth. Thou must learn to distinguish the temperament, the sanguine, the choleric, the melancholy, and the phlegmatic, together with their related sources, the blood and the gall, also their corresponding principal organs. Thou must give attention also to the senses and their powers, seeing, hearing, tasting, smelling, and feeling; also to the inner powers, the imagination, memory, and reason; also to the animal powers, activity and repose. By the sick man himself lay thy hand upon the pulse.

"Dost thou desire to become a poet, so give heed that thy expression in the poems be clear and plain. Shun dark speaking; write not poetry without imagery, taste, or art.

"Dost thou desire to learn music, then must thou be well-habited and friendly, not of evil habit and ungracious. When thou comest into the company, be not always playing light songs and melodies, or always playing hard and difficult pieces. For the people assembled are not all of one nature, but are often quite opposed to each other; as generally men are not all of one taste. Therefore must thou be instructed in all forms of melody and various kinds of instruments, that all the people may receive pleasure.

"Lastly, my son, art thou called to be a ruler—guard thyself from all that is forbidden. Reach not out thy hand after another's possession. In all things thou undertakest, first seek to bring thy desire into harmony with thy understanding; then begin the matter. In no affair over-haste thyself, but when thou hast hit the fitting time then come to the work. In all things regard consequences—a ruler must be sharp-sighted, and consider the end. And whatsoever possessions thou mayst have, and whatsoever occupations thou mayst pursue, seek always to reflect upon the beginning and the end; seek to know eternity and to gain the honor of the virtuous, that, among all men, thou mayst be one of the most excellent."

These words show a culture of which no people need be ashamed. Were there power to apply their wisdom in our day, life would enter upon its fuller fruition, and men would be more helpful one to another, because more noble.

[*To be continued.*]

HEREDITARY DISEASES AND RACE-CULTURE.

By GEORGE J. PRESTON, M. D.

TO any one who will scan the human race, from the time when Greece and Rome were in their zeniths, down to the present day, it will be apparent that men have degenerated physically. We may have high examples, here and there, of some specialized feats of strength or skill, but, taking the races man for man, we are vastly inferior physically to the Greeks. One prominent cause of Grecian ex-

cellence occurs naturally to all, namely, the necessity for and the high premium set upon physical superiority. Among a people where "all were for the state," and patriotism was the ruling passion, each man held out his life to the state whenever she saw fit to use it, and the state took care that the sword-arm should be well developed. Gunpowder and the implements of modern warfare had not yet rendered all men equal on the battle-field. To have gained a prize at the Olympian games was enough to raise a man, and with him his family, from obscurity into prominence. As the race has progressed, the need for physical force has grown less and less, until at the present day the term physical force, or, as we oftener hear it, brute force, has almost become an opprobrious epithet.

A fallacious notion has somewhere crept in that an *intellectual* man must be below par *physically*, and that the one faculty is necessarily cultivated at the expense of the other. The old proverb, *mens sana in corpore sano*, has been flouted as an absurdity. So much, very briefly, for the first cause of race-degeneration; the second, and the one to which this paper would direct attention, is the influence of hereditary diseases. This factor has never received the attention it should have had at the hands of the writers on social science. The races of which we have been speaking had little of this element to contend with. The weaklings were either deliberately exposed and left to die, as in the case of the Spartans, or if they attained maturity they were held in such low esteem that they willingly kept in the background. Look for a moment at our modern civilization, and mark its diametrically opposite tendency. Every day hospitals are being erected to nurture the diseased and imperfect specimens of our race, and every year thousands of children are by skill and care saved from the death to which Nature would consign them. All this accords with our enlarged notions of humanity, and reflects great credit on the zeal of the philanthropist and the science of the physician, but it exerts a baneful effect on the race. To one who has had access to any large city hospitals, it is a pitiful sight to see the multitude of children who are tided over a few years, and sent out into the world branded with an hereditary taint, to propagate their wretched breeds. The limits of this paper will not allow any extended statistics, nor the nature of it warrant a special discussion of hereditary diseases, but there are two whose effects are apparent to all, consumption and insanity. The former, consumption, using the term in its widest sense, has for ages produced the most frightful ravages. For example, in England, from 1837 to 1841, of the total number of deaths from all causes sixteen per cent were from consumption. In Philadelphia, from 1840 to 1849, the death-rate was one of consumption to six and a half from all other causes, or about fifteen per cent.

Of late years, however, the mortality has been somewhat reduced by a more successful plan of treatment. As regards insanity "in the

different civilized nations of the world, there is an average of one insane in five hundred inhabitants. The undoubted steady increase of the insane under care and observation would seem to be greater than can be fairly accounted for by the greater attention now given to their welfare" (Maudsley). These two instances, recognized as the most important in the hereditary class, will serve as examples; it is not desired here to show in what proportion of cases disease is transmitted from generation to generation; the writer hopes to be able at a later date to give some general laws respecting hereditary affections.

The *heredity of genius* has been fully proved by that very interesting writer and accurate observer, Francis Galton, and he has put forward in a masterly way the claims of *eugenics*, or race-culture. This must be effected, he urges, by a rational system of natural selection. "Men," says the same author, "have long been exempted from the full rigor of natural selection, and have become more mongrel in their breed than any other animal on the face of the earth." The laws of natural selection, considered broadly, prevail among men more than at first sight appears.

Among the lower animals, as Mr. Darwin has shown, strength, beauty, voice, and such qualities, determine a choice: the rustic maiden often chooses her husband because he is stronger physically than his rivals; the more intellectual woman would naturally look for mental superiority, and so on. Now, the strongest point in any rational natural selection must be first and foremost pure blood; and by that is not meant blood that has come down through a long line of ancestors merely, but blood which is free from any hereditary taint. We are all familiar with the member of some "old family," a slight, flat-breasted, precociously intelligent child, whose slender, graceful neck, bright eyes shaded by long lashes, thin, white skin through which the blue veins show, declare to the educated eye the presence of tubercular disease. We know that, if such a child matures, the odds are overwhelming that its offspring will continue to disseminate the disease. Or take any number of insane persons, with whose family history you are more or less familiar, and the certainty with which you will be able to trace the disease to hereditary predisposition is wonderful. We know of no government sufficiently strong to forbid the banns of a man whose lungs are full of tubercle, or of a woman upon whose person cancer has shown itself. The only way to begin to stamp out hereditary disease is to direct the tide of public opinion toward it. We would not if we could enforce the Spartan rule, but we can and should exert a power they knew not of, the press, and educate our people to the full importance of this subject. Even our proverbial *mauvaise honte* can not object to showing the young of both sexes the horrors of a legacy of an hereditary disease. Those who are to become the fathers and mothers of our next generation should be warned before they make a step into the dark, and should

feel that it is a duty they owe, not only to themselves, but also to their country, to propagate a pure race. It is repugnant, at first thought, to speak of "breeding" men and women, but this very repugnance to handling a subject surrounded by so much delicate reserve has been largely conducive to the race-degeneration. We know that the race should be improved; every year, as has been shown, pours its rapidly increasing mass of impure blood into the general current. A man with one or more hereditary diseases on his side, and a woman with a like number among her ancestry, make it almost impossible for their offspring to escape.

We know that the race can be improved, as is shown by analogies among the lower animals. How paradoxical it seems that a man who would scout the idea of breeding his stock to diseased animals should yet without a word of opposition see his children marry into families where the hereditary taint is marked. Yet such is undoubtedly the fact. Ignorance must be the prime cause of much of this misery; for the certainty with which some diseases reproduce themselves in succeeding generations is a fact which can be proved, and not a mere set of coincidences as many suppose.

The theory that healthy blood on one side of the house is sufficient to counteract the diseased of the other is, unfortunately, fallacious. The predisposition to hereditary disease will often survive many influxes of pure blood, and the currents may, like the clear and sparkling Rhone emerging from Lake Geneva, and the dirty-gray Arve from the glaciers, run side by side for a while, separate and distinct, but at last they mingle, forming one turbid stream.

EVOLUTION IN ARCHITECTURE.

By FRANCIS H. BAKER.

THE disciple of Darwin labors under one disadvantage. The periods necessary for maturing the changes which he investigates being so immeasurably superior to those relating to ordinary mundane affairs, he can not verify the sequence of the events by the independent testimony of contemporary history. It would be interesting to apply the theories of development and natural selection to some department of knowledge in which we could have that aid.

Human society is so largely subject to the influence of emotions which appear to have little or nothing in common with the orderly operation of natural laws, and its course is so checkered with action and reaction, that it is often difficult to follow any particular line of progress for a length of time. Examples of regular development are, however, not wanting, and one of the most striking is to be found in the history of architecture. To a person ignorant of such history

there would appear to be no connection between a Gothic cathedral and a Greek temple, beyond the facts that both were buildings of stone, and both had been dedicated to religious worship; yet that one has been evolved out of the other is a matter of simple demonstration. We can supply all the links of the chain by referring to edifices still standing, the times and circumstances of the erection of many of which have been detailed by the general historian.

To find the source from which the European nations have derived the art of building in stone, we must look to the land of the Pharaohs. From Egypt the craft passed to Greece, and from the Greeks it was taken up by the Romans, to be by them disseminated through the north and west of Europe in the process of colonization. The similarity, in regard to the constructive parts of the ancient Greek buildings to some of those found in Egypt of older date, affords strong confirmation of the tradition that the Greeks borrowed the art from the Egyptians. The Greeks, however, in adopting it added a new feature, the pediment, and the reason for this addition is easy to find. Egypt is practically rainless. All the protection from the climate required in a palace or temple in such a country is shelter from the sun by day and from the cold by night, and for this a flat roof, supported by walls, or pillars with architraves, is quite sufficient; but, when, as in all European countries, rain has to be taken into account, a slanting roof becomes a necessity. The Greeks, with their eye for symmetry, provided for this by forming the roof with a central ridge, at an obtuse angle, from which it sloped down equally on either side. The triangular space thus formed at the end of the building above the architrave was occupied by the pediment, and this part of the façade, which owed its birth to the exigencies of climate, was thenceforth regarded as so essential to the artistic completeness of the work that it was said that if a temple were to be erected in the celestial regions, where rain would not be possible, the pediment could not be omitted.

Both the Egyptians and the Greeks were satisfied with bridging over the openings of doors and windows, and the spaces between columns, by means of the architrave, a mode of construction which involved the necessity of using long blocks of stone. But the Romans, whose enterprise took a wider range, were not content to labor under such restrictions. In their engineering works they were familiar with the principle whereby blocks of comparatively small size, arranged in a semicircular form, can be made to hold together without support from beneath, except at the two ends of the series, by being arranged in the form of a semicircle; and, applying this principle to architecture, they not only gave to art a freedom it never before enjoyed, but conferred on it a new element of beauty. The arch, unknown to the Greeks—or, if known, not made use of in their temples—and employed by the Romans in the first instance from utilitarian motives, has ever

since been an important, often the most important, feature in architectural works.

The Roman architect was thus in possession of all the constructive elements—pillar, architrave, pediment, and arch—which distinguish an architectural edifice from a building merely made up of walls and a roof. Without speculating as to the origin of pillar and architrave, with their subsidiary elements of plinth, capital, cornice, etc., it is clear that the last two—the pediment and the arch—resulted from the pressure of new and external circumstances. Into the history of the orders we need not enter. Their function is that of ornament, and the choice of their forms was probably governed by considerations of taste rather than the requirements of situation. The classic architecture in the best examples presents all the characteristics of a finished and matured art; and if the old civilization had been maintained, in the old places, though an additional order or two might perhaps have been invented for the sake of variety, there is no indication that there would have been any important change in the style of building. The disintegration of the Roman Empire, however, and the triumph of the barbarians, brought into play an entirely new set of forces, and prepared the way for that wonderful series of beautiful and ever-varying creations which we know by the name of Gothic architecture.

Can we discover what it was that inspired the mediæval builders in the production of forms of so much beauty, often at times when all other arts were dead and gross ignorance abounded? One consideration may help us. The periods of the Gothic styles (including those which led up to the styles to which the term is sometimes restricted) are precisely those which are called the *dark ages;* and in the successive changes through which the art passed in those ages can we not perceive a *yearning for light*—light in a threefold sense—religious, artistic, and physical?

1. Moral or *religious* light. An upward tendency now begins to manifest itself. There is an evident disposition to make the buildings appear as if springing up from the earth, instead of resting upon it. In the temples of antiquity all the principal lines are horizontal, in agreement with the surface of the earth; in the mediæval buildings the tendency of the prevailing lines is to assume a vertical position, pointing heavenward.

2. Artistic *lightness.* The Greeks and Romans appear to have paid little regard to economy of material in the construction of their public edifices. Many of their works seem to rely for their effect chiefly upon their massive grandeur. But the Gothic architects seem to have been distressed with the weight of the material in which they worked. They found means, from time to time, to diminish its weightiness, in appearance at least, by diapering, molding, and tracery.

3. *Physical* light. Under the semi-tropical skies of Southern Europe, little regard had to be paid to this blessing, beyond providing

against its excess. On the removal of the centers of civilization northward, the openings for the admission of the light of day became objects of solicitude, and thenceforth the windows are the principal parts of the wall in which they are pierced.

A naturalist of the new school might describe to us the changes which would be induced in a plant or other organism translated from the sunny climate of its birth to the cold and murky atmosphere of the north, and surviving, by virtue of its "fitness" for a place in its new home. Let us follow, as rapidly as possible, the behavior of the art of building in like circumstances. In doing so we may conveniently take the examples to be found in our own island; for, although the Gothic architecture prevailed throughout the greater part of Europe during the middle ages, it ran its course with greater regularity, and for a much longer period, in England than on the Continent. Owing chiefly to its geographical position, this country was the first to lose the connection with imperial Rome, and the last to feel the full force of the Renaissance.

The first effect of the new state of things was in a direction completely opposed to the aspirations to which we have referred. The general sense of insecurity which followed the withdrawal of the Roman legions made the strength of their walls the first care of the early builders, and windows and doors were necessarily reduced to the narrowest dimensions. Hence the heavy character of the styles denominated Romanesque, represented in this country by Saxon and early Norman works. The relative measurements established by classic taste were everywhere ignored by the Christianized barbarians; and, if even our rude Saxon forefathers could have appreciated them, they must have been abandoned through necessity. There are no complete buildings in this country which can be pronounced with certainty to be genuine Saxon works. For a description of the buildings of that period we are dependent on the accounts of early writers, aided by fragments which have been incorporated with works of later construction. The Saxon churches are described as low, small, and mean, with very thick walls, and floors sunk below the level of the ground.

For four hundred years our ancestors endured these dark, dismal stone erections—that is to say, where they enjoyed the luxury of a stone church, for probably at that time most of their religious buildings were, like their houses, of wood. Two interesting features, however, relieve this dreary period. One is the triangular-headed window, a remarkable anticipation of the pointed arch; and the other, the insertion of a small pillar in the center of some windows, which is evidently the forerunner of the mullion. An excellent example of a window in which both these peculiarities are combined is to be seen at Barton-upon-Humber. The date is about A. D. 800.

Toward the end of the tenth century a first step was made in the

direction we have indicated, by raising the central portion of the building above the roof, in the form of a low, square tower. This served as a lantern for the admission of light. In the eleventh century, when the Norman period commenced, the upward tendency was much more marked. The buildings generally were more lofty, and the tower especially was heightened. The splaying of windows—a device evidently brought about by the desire to obtain the maximum of light through the narrow openings in thick walls—now became general. The early Norman buildings retain in general the Romanesque character of massiveness, but efforts to relieve this are apparent in the rich carving of doorways, the occasional wreathing or other decoration of heavy supporting pillars, and the use of light arcades for mere ornament. The circular section of the pillar is no longer strictly adhered to, but hexagonal and octagonal pillars are freely used, and sometimes four shafts are combined into one pillar, the commencement of the clustered form so conspicuous in later styles. But the most important invention of this period was the buttress, which rendered it possible to raise the height of a wall considerably without the necessity of adding uniformly to its thickness.

In the twelfth century architecture began to develop in well-defined forms the peculiar character which we distinguish by the term Gothic. With the view, doubtless, of providing more effectually against the inclemency of northern climates, the pitch of the roof had been raised, until, at the time to which we refer, the ancient pediment had grown into the mediæval gable. Another important change was the introduction of the pointed arch. Of the writers who have put forward their own particular views as to the origin of the pointed arch, it may be said their name is legion. The theory that it was suggested by the interlacing of the branching of trees is a pretty one, but, we fear, must be relegated to the domain of poetic fancy. It would have had more force if it could have been applied to classic architecture, and not to Gothic, as the worship in groves intimately connected with paganism, whereas the Christian religion is associated in its early days with caves and catacombs. The hypothesis that it is an importation from the East, one of the results of the Crusades, has much to be said in its favor. Pointed arches had long been used in Oriental buildings, and they are even found in Assyrian remains. The intersection of arches carried to alternate pillars in ornamental arcades—a form frequently met with in Norman buildings—produces a perfect pointed arch. But whatever was the immediate cause of the adoption of this form, it is an expression in a high degree of the principles which governed the development of the art in the middle ages. It marks a distinct advance in the pursuit of light, in all the three senses mentioned above. Not only is the central portion higher than that of a semicircular arch, but the construction is such as to suggest that the support of the pillar is carried upward through the

imposts into the arch itself, instead of the force being directed downward, as in the Roman arch.

The pointed arch made its appearance in the several countries of Europe almost simultaneously, but it took nearly a hundred years to entirely supplant the round arch. During that time pointed and round arches were used indifferently in the same building, as occasion might require or taste dictate; but in the thirteenth century the pointed form was finally established. Another change is now apparent, showing the application of a principle which, perhaps more than any other, distinguishes the best examples of Gothic architecture—a desire to rely for the beauty of the work on the form and arrangement of the constituent parts, and to make it as independent as possible of added decoration. This is evidenced by the deeply cut moldings, in continuous lines, strongly marking out the construction, which are so noticeable in what are called "Early English" buildings. More lightness is also obtained by means of clustered pillars, molded arches, tracery in the windows, and especially by the use of buttresses. The buttresses, first used to give additional strength to an already substantial wall, were completely altered in form. Instead of being, as in the Norman period, broad and flat, projecting but slightly from the surface of the wall, they were now placed with their breadth at right angles to the wall. They were also lightened by being divided into stages, and divided in their lower parts by arches. By this arrangement the weight of the roof and upper portions of the building was transferred to points outside the walls, and this enabled immense progress to be made in the light-seeking principle by leaving a much larger portion of the sides of the building available for windows.

The art having now assumed a definite and decided character, the succeeding varieties of style show a steady progression on the lines established. The simple pointed arch was formed by describing it from two centers instead of one; by using more centers, trefoils and quatrefoils were obtained, and the intersection of the circles produced the cusp, another form of point. Points now appear everywhere; buttresses are prolonged into pinnacles, and towers are surmounted by spires. Ribs under arches and vaults are multiplied, to distract the eye from the weight of the material which they appear to support. Horizontal lines and divisions gradually disappear, or are broken up, until in some cases there is no line to mark where wall ends and roof begins. Even the beautiful geometrical forms of the fourteenth century had to give way to the perpendicular, which in the fifteenth century reigned supreme.

As an example of mediæval architecture at the highest point of development it was permitted to reach, we may take the chapel of King's College, Cambridge, one of the finest specimens of advanced Gothic art in Christendom. On entering the chapel the prevalence of the upward principle is at once apparent. On either side innumerable ver-

tical lines lead the eye upward from the richly decorated ground-panels to the gorgeous walls, which are of crystal, for the stone-work is seen only as the framing of the glass, as the division between the windows. The light of day is not admitted plain and undivided, to show up fresco or canvas, but, resolved into its constituent colors, it is forced itself to paint, in rainbow tints which no surface pigment could produce, the chief events connected with the religion of the worshipers. First we see depicted the scenes of old Bible story. Past these pictures—through them—the lines flow up, and show us the corresponding incidents and revelations of the New Dispensation. Type is succeeded by antitype, and the dim teachings of the Law are seen perfected in the clear light of the Gospel. Still upward fly the lines. Drawn in dull, heavy stone as they are, they can not lead us up to heaven, but, having helped to point the way, they divide into branching curves, and bound our upward vision with a canopy or roof of spreading fairy fans. This roof is really a vault of solid masonry, in some places more than three feet thick, yet there is not a single pillar to indicate that it needs support from below. Not an inch of the material is hid, but by simply chiseling its surface the ponderous mass is completely veiled by the cobweb texture of the tracery. To appreciate the solidity of the structure, we must ascend and inspect the rough upper surface of the stone. Only then do we become sensible of the weight of the huge blocks, some of them weighing over a ton, which, by the masterly system of vaulting, are made, simply by the force of their own gravity, to bridge over the awful abyss beneath. To find the source from which the enormous weight of this roof derives its support, we must go outside the building and examine the buttresses which flank the building on either side. The strength of these is not apparent at first sight, for the lower parts, of course the most massive, are massed by connecting walls, and the intervening spaces thus inclosed are utilized as chantries, leaving only the upper and lighter portions visible. On comparing this chapel with some of the richest Italian interiors, the peculiar character of beauty already referred to as distinguishing Gothic art is at once perceptible; the decoration, instead of being superadded, is bound up with the construction; the parts themselves are made to provide the ornament. From an æsthetic point of view this noble chapel is a consummate work of art; as an example of mechanical ingenuity it is a triumph of engineering skill.

This work was commenced in the middle of the fourteenth century, but not finished till the fifteenth century was far advanced. By this time, however, there were unmistakable signs that the reign of the upward-pointing principle was drawing to a close. Arches were depressed, right angles abounded, and square-headed windows were used, not only in situations where they might be convenient or appropriate, but in such important positions as the east end of a cathedral, as at Bath Abbey.

The perpendicular style was peculiar to England. On the Continent the fifteenth century gave birth to a variety of "after-Gothic" styles, mostly remarkable for extravagance and want of taste, and which speedily disappeared before the classic form which had already been revived in Italy. In this country, however, Gothic architecture died hard. The English art continued to maintain its individuality for fully a century, though deprived in a great measure of its elevating spirit. The Tudor or Elizabethan manner, though very successful in baronial mansions, and peculiarly applicable to "domestic" purposes, has a distinctly "debasing" effect when applied to ecclesiastical edifices. The growing influence of the Renaissance also, in the attempts to graft classic ornaments and composition on mediæval forms of construction, produces often a mongrel effect. In a word, the natural development of architectural art was arrested. Before the end of the seventeenth century the triumph of the Italian school was complete. The mediæval art was opprobriously branded with its present name of Gothic, and the sublime fanes which it had produced became, in the language of Sir Christopher Wren, "mountains of stone, huge buildings, but unworthy the name of architecture." The feeling was, in fact, that we had been traveling along a wrong path, and should return to the point at which the art was left by the Romans.

At the present day the classic and the mediæval modes have each their partisans. We will not here attempt to discuss the merits of the rival styles. We will only point out that while the classic art embodies the finished conceptions of the ancient schools of thought, the Gothic is associated with the chain of events which mark the struggle for national liberties. The one represents satisfaction with an existing state of things, the other progress toward an ideal. Having won our liberties, we can study in peace the laws and usages of by-gone ages. Having solved the problem of adapting the ancient art of building to the requirements of modern times, we can indulge our fancy in the selection of our models.—*Gentleman's Magazine.*

INDIAN MEDICINE.

By G. ARCHIE STOCKWELL, M. D.

THOUGH it speaks little for modern civilization, the masses of the people are wont to esteem the savage as preternaturally wise in the secrets of Nature, more especially in the prevention and elimination of disease, accrediting him with knowledge botanical, pharmacal, and therapeutical, that if possessed of but a shadow of reality would be little less than divine. In this we have interesting evidence of man's tendency to reversion, and of lingering attributes of the final state of his awe in the presence of the occult, and inherent worship of the

unknown; for how frequently one encounters, in all ranks and classes of society, individuals who, in spite of refined teachings and surroundings, exhibit an unmistakable taste for charlatanism in some of its many forms, secular and spiritual!

"Medicine" as exemplified among the savage races and tribes of America is practically one and the same with the "shamanism" of the European and Asiatic nomad, the "fetich" of the native African, and the "obi-rites" and "voudoo-worship" of West India blacks and negroes of the Gulf States; a careful examination of all reveals not only a common origin, but a unity of purpose.

The "medicine" of the Indian is his religion and philosophy; and it comprises everything in life and Nature, real or imaginary, superstitious or occult; and withal it is a mystery so subtile in its many factors as utterly to defy specific definition, or perfect elucidation.

The "medicine-man" is no more a physician, in the modern and enlightened acceptation of the term, than an ape is a man because it chances to assume the erect posture and mimic the attributes of the human race; there is a slight analogy, but nothing more. The savage knows absolutely nothing of the relationships existing between cause and effect, of the action of remedies *as* remedies, of physiological conditions and phenomena, or indeed of any agency that is not directly born of the occult. He supposes the world and its circumambient ether to be permeated by spirits, good, bad, and indifferent, who determine the fortunes of men and regulate the phenomena of Nature in accordance with individual will and fancies; and who also bear some mysterious and indefinable relationship to each other, and to one "Great Spirit" or *Supreme Power* who figures under a variety of guises and titles, according to circumstances and surroundings, such as "The Old Man," "Nine-bouzche," "Si-ce-ma-ka," "Kitche-Manito," "Great Manito," etc. Manito, Manit, or Manitou, however, is not an appellation alone singular to the *Supreme Power*, but under certain conditions is equally applicable to any and all spirits; in other words, it may be used *generically* as well as *specifically*. Then, too, there are certain sprites or gnomes, "Little Men," invisible dwarfed inhabitants of portions of the earth, who would seem to be satellites of the spirits proper, but whose position in savage demonology is by no means satisfactorily defined.

Good spirits receive little attention, and are never objects of worship, since their acts, influence, and purposes are obviously for the best. But the evil and half-way malevolent demand constant supervision and placation, lest the smooth workings of Nature be interfered with, and the normal destinies of man perverted. A journey through the Indian country affords ample evidence of this belief in frequently recurring offerings suspended from trees, bushes, and wands, or conspicuously exposed upon rocks, knolls, and open places, such as broken

or discarded glass, metal and bead ornaments, shreds of skins, bits of painted leather, bright ribbons, strips of gay calicoes, feathers, pieces of tobacco, and bundles of human and animal hair.

The true "medicine-man" (for there are charlatans and pretenders * in savage as well as civilized circles) is one of a fraternity most mysterious and despotic in its ways and workings, membership therein being limited to those who exhibit more than ordinary fitness therefor, backed by powerful family and tribal influence. In one sense "medicine" is an autocracy; and it is also the nobility of the savage, no way limited by tribal power, and is forbidden to women except for very extraordinary and specific reasons. Its apprenticeship, too, is long and arduous, beset throughout by trials and stumbling-blocks, calculated to tax to the utmost the patience, faith, endurance, and fortitude of the candidate, and to betray the inner consciousness and latent foibles of the individual. Having passed the prescribed ordeals, he is admitted into full fellowship amid ceremonies calculated to be most solemn, impressive, and binding. One of the labors prescribed, and frequently performed in public on the evening of the annual "goose-feast," is as hideous as it is sickening. It consists in devouring a live dog, and is a proceeding that especially obtains among the Chippewyans, Crees, and Ojibways; and a more horrible or fiendish scene, as viewed by the flickering fire-light amid sounding drums and rattles, the shrieks of the victim, and the frenzied howls of the assemblage, can not be imagined.

Disease, from a savage standpoint, is not a mere morbid phenomenon, but the specific manifestation of some demon or spirit of evil, who through a kind of occult intelligence or agency has obtained control of the person; and, naturally, relief is deemed possible only through agencies that have their inception in the miraculous and supernatural. Under such circumstances the most absurd ideas obtain both among laity and fraternity, and remedial measures are irrelevant, crude, and not infrequently most barbarous. Think, for instance, of the fauces, including the soft palate and muscular tissues of the throat, being forcibly wrenched out by a pair of bullet-molds in the hands of an "Indian doctor" or medicine-man, and for the relief of a tickling cough due to an elongated uvula! Such is a veritable occurrence; and yet the operation was not due to an appreciation of the difficulty, but was intended to dislodge a spirit that had taken possession of the part! It is perhaps needless to remark that it was successful, in that it not only dislodged the spirit of the disorder, but that of the sufferer as well.

All medicine-men of first rank are clairvoyants and psychologists (mesmerists, if you like) of no mean pretensions, as a rule capable of

* Many an individual, renowned as a warrior and respected at the council-fire, becomes the jeer of his tribe because of his pretensions to "medicine," which have not been legitimately acquired, or of which he is not possessed.

affording instruction to the most able of their white *confrères;* * and to be a medicine-man at all demands that the individual be not only a shrewd student of human nature capable of drawing deductions from matters seemingly most trifling, but also an expert conjurer and wizard. I have repeatedly known events in the far future to be predicted with scrupulous fidelity to details, exactly as they subsequently occurred; the movements of persons and individuals to be described in minutiæ who had never been seen, and were hundreds of miles away, without a single error as to time, place, or act; and I have witnessed feats of legerdemain and necromancy that would appall a Houdin or a Heller, executed in broad daylight, without mystic aids or surroundings. I have seen guns, manifestly in perfect order, fail to execute their mission while in the hands of most expert marksmen, merely through a look, a touch, a word, or a bit of incantation; and yet again restored by a like process.† But here, as may readily be surmised, the trouble was not with the weapon, but with the man behind it, whose will-power was not equal to the task of overcoming his native and inherent superstition. Again, it has been my fortune to witness feats so astounding that I dare not place them upon record lest I be accused of romancing; some, to be sure, susceptible of explanation under physical and psychical laws; others not so easily or satisfactorily disposed of, except perhaps as tricks of the imagination, "optical delusions," etc.; and even as to these few would be willing to admit that, of an audience numbering some scores, all could be successfully deluded.

Having already intimated that the Indian relies chiefly on incantation and conjuration to produce specific effects, it is readily understood that success is due to the impressions produced upon the great nerve-centers. Just as the ancients esteemed the ear and nose the highways and emunctories of the brain, the special senses of hearing and smell become the foundation of all savage physiology, and consequently are appealed to in the most emphatic and comprehensive manner. Noise and odor are ever the prime factors in the *armamentarium therapeuticum* of the medicine-man, and it is no exaggeration

* The Indian recognizes the fact that clairvoyant and psychic power may be inculcated and developed *de novo;* that it may be brought about by certain conditions that stimulate, or disarrange and disorganize certain nerve-centers, and he consequently prepares for more formal and eventful measures by fasting, long vigils, and other acts that develop extreme nerve-sensibility. A white man I once knew always developed extraordinary psychic and clairvoyant powers during or just subsequent to a prolonged alcoholic debauch that had been accompanied by excessive sexual indulgence, *and at no other time!*

† Horses and men have been known to lose control of their limbs through the machinations, incantations, etc., of a medicine-man. One case known to me was that of a famous Indian runner, who was deprived of all save ordinary use of his legs. Another case was that of a stallion invaluable to its owner as a buffalo-hunter, which became practically useless until it passed into the hands of a hard-headed, non-superstitious Scot, when it suddenly regained its powers!

when I assert that whole families, especially during the ravages of epidemics, are frequently and literally drummed, rattled, stank, and powwowed out of existence. Conceive of a child with its peculiarly sensitive nervous organization, prostrated with burning fever, kept in a close and stifling atmosphere and subjected to combinations of sounds and smells fit to launch an adult in full tide of health into the very depths of lunacy! Why, the din is so very infernal in character, the odors so intensely nauseous and suffocating, that the wonder is that *any recover*. Seemingly the most obstreperous of spirits, even the "Old Harry" himself, would be forced in self-defense to stop ears, clap fingers to nose, and flee to the uttermost confines of space!

The demonology of the red-man seemingly provides for various classes of spirits possessed of like attributes (but more exaggerated) with man. Some are strong, bold, persistent, revengeful, malevolent beyond measure, and but sparingly amenable to discipline. Others, again, are mild, weak, vacillating, forgiving, indifferent, easily placated. One of the latter may be got rid of, sometimes, with little trouble and ceremony; but an old and accomplished individual not infrequently demands the combined wisdom and efforts of a dozen or more conjurers, while days and even weeks may be consumed ere a successful (or fatal) issue is reached. Then there are various creeds, or articles of faith, that would appear not to be definitely settled (theologians and physicians the world over will disagree!), and it is a somewhat mooted question as to how the evil ones are disciplined, and whether they are coaxed or frightened from their hold upon the victim, altogether annihilated, or amenable to all three measures. In one thing, however, the fraternity is united; in any event, the treatment is the same!

The medicine-man is no sooner summoned, than he begins to enact the part of a *leech* in very truth. Above all things, he must feast, and that, too, almost incessantly, and upon the very best the surroundings afford, else he can not sustain the strength necessary to a struggle with the denizens of the spirit-world; and it frequently happens that not only the family of the sufferer, but all his blood relatives even to the most remote degree (and this is enforced by a very nice point of savage honor), are thereby rendered hopelessly bankrupt!

An examination, to determine the condition of the sufferer, is not at all essential, since the conjurer possesses an infallible means of diagnosis in the charms and amulets that stuff to repletion the "medicine-bag" that is constantly worn suspended from the neck; through these he derives power to mingle with the inhabitants of the unseen world, and to bring before his mental vision the entire physical and spiritual economy of any individual of earth or air at will. Summoning to his aid an assistant or assistants, he proceeds to his incantations without the least questioning or circumlocution, beginning with a low, monotonous chant rising and falling with abrupt inflections, wherein he begs,

implores, and commands the spirit to abjure the mortal clay and assume his own proper form, alternately humoring, coaxing, and threatening, as circumstances seem to demand, at the same time using set songs whose significance is unknown outside of his own mystic calling. In the mean time a running accompaniment is kept up by means of drums, bells, and gourd and parchment rattles. By-and-by the song waxes louder and more violent; the drums are pounded harder and faster, and the rattles and bells are shaken more forcibly. Higher and higher the sounds rise; shriller and shriller his voice is pitched; and faster and fiercer the accompaniment sounds, until the one becomes a frantic shriek, the other a pandemonium of most fiendish character, together crazing, piercing, and excruciating beyond computation; and, finally, exhausted by the violence of his efforts, fairly black in the face, with perspiration streaming from every pore, he pauses and—EATS! A starved wolf is a miracle of satiety by comparison; and he is ably seconded in his gormandizing feats by the assembled and admiring audience.

Over and over again is this performance repeated, while the smoke and fumes of burning gunpowder, fish-entrails, human excreta, buffalo-chips, and animal hair,* fill the interior of the lodge to suffocation, producing *stinks* that may fairly be *felt*. And, finally, when the excessively tormented and vexed spirit is sufficiently placated or frightened, and on the point of departure, his exit is facilitated by rapidly recurring discharges of musketry in and about the dwelling and over the body of the sufferer. When the friends are sufficiently wealthy, the fusillades are frequently prolonged for hours or days, to prevent a return of the (demon) malady.

But the spirit does oftentimes return in spite of every precaution; for naturally a relapse is coincident with the cessation of the incantations and the departure of the "medicine-man," or rather with the subsidence of the nervous excitement induced by such extraordinary procedures. Such unfavorable result matters little, however, as the superstitions inculcated render the officiating conjurer practically unassailable. It is to be expected that a demon or spirit imbued with a proper amount of pride and self-respect will return with the first opportunity, requiring new and perhaps varied incantations. The stronger and more persistent the demon, the greater evidence of power on the part of the medicine-man. Everything is made to redound to his credit; consequently, the spirit is effectually disposed of only when sufficiently bribed, thoroughly overreached, or utterly annihilated—only when Nature comes to the aid of the unfortunate and affords the necessary

* Certain creatures, of the *Mustelidæ* and *Canidæ* especially, are esteemed *medicine*, such as the beaver, mink, fisher, marten, musquash, skunk, otter, weasel, wolverine (*very powerful medicine*), dog, fox, wolf, moose, bear, musk-ox, bison, rattlesnake, blacksnake, puma, lynx, sturgeon, cat-fish, and lake sheep's-head (*Haplodonitus grunniens*)—"*great medicine.*"

relief, or death intervenes and claims his victim! If a fatal issue results, numberless excuses, always most reasonable, are at hand. There may have been a *new* spirit, or the Supreme Power may have interfered in behalf of the *old*, decreeing that it should work its full will, probably in retaliation for some vow made in the remote past and neglected or forgotten—hence, a just punishment! Under any circumstances nothing remains to be said, and the philosophy proves most satisfactory and comforting all around. One thing, the Indian *never changes* "*doctors*"; and, if another conjurer is summoned, it is always by or in consonance with the wish of the one in attendance.

One "powwow" that I witnessed among the Ojibways—my first experience by the way—engaged the talent of no less than a dozen "medicine-men" and nearly double the number of tyros still in their novitiate. Gathered from remote distances and points wide apart, some coming more than two hundred miles, they rallied under the leadership of one most famous in his day, so much so that his reputation traveled far beyond the precincts of his tribe; and, when gathered together, a more grewsome and spookish crew it would be difficult to imagine outside of Pluto's especial domain.

The leader or "great man" certainly deserved the distinction accorded him, if for no other reason than size and stature, he being a veritable son of Anak, considerably more than a "Saul among his people," and above thirty stone in weight. He was gorgeously figged out, and presented all the extremes of savage grandeur and frippery. From his shoulders hung a massive robe of black bears' skins lined and elaborately trimmed with scarlet; fringed blue-cloth leggins, a miracle of beaded work, and moccasins of caribou-skin ornamented with the same and with the dyed quills of the porcupine, clothed his nether extremities; ornaments of metal, of glass, of wampum, along with little bells, were artistically draped and hung from every available point; an elegantly wrought "medicine-bag" of mink-skin, and a large silver medallion of "her Most Gracious Majesty" hung suspended from broad ribbons about his neck; paints of various colors, green and vermilion predominating, daubed with no sparing hand, hid the natural hues of flesh wherever exposed; and, to cap all, his crown supported the head of a wapiti stag or Canadian elk, prepared in life-like manner as a helmet, and surmounted by immense antlers more than five feet high. Gurth's "Visions in Dreamland" ne'er produced so wild a "huntsman," or figure more Satanic; and, all in all, the costume was as striking and *bizarre* as one could ask to see.

His following were in a general way his humble imitators, but less grand and imposing. All displayed marked originality and taste in producing the hideous and striking. There was, of course, a profusion of unique ornaments and of paint, distributed with a view to the effect that might be produced upon patient and audience, and varying and bewildering results were obtained. One had his face completely

hidden with transverse bars of yellow and vermilion, and a ring of black about the eye; a second had daubed his countenance with black, painting the orbits white; another employed white and black in alternate horizontal bars, with eyes set in a deep border of bright vermilion; still another hid his face behind a mask of ochre; and a fifth wore a wolf-skin robe, the head of which supplied a covering for his own. The acolytes, or assistants, save for the instruments they bore, and the medicine-bags suspended from their necks, differed little from their brethren of the laity.

The scene was night, close upon the "witching hour"; the place a natural opening, less than thirty yards in diameter, in the midst of spruces, cedars, and towering Norway pines; a bright moon threw but fitful gleams of light, the rays straggling in here and there only serving to render "darkness visible"; even a small fire kindled near the center in no way tended to disperse the gloom of the surroundings, its beams but magnifying all within their radius into ghastly shades and shadows that danced fitfully and spectrally over the dark evergreen background, giving the solemn and weird character demanded in such proceedings, aiding to impress the beholders with the idea of the mysterious and supernatural.

The unfortunate in whose behalf the medicine* council was instituted was a man just past the prime of life, who but a short time before had been stricken with paralysis that involved in varying degrees the entire right half of the body; the hand and arm were entirely dead to sensation, and no way amenable to the will. He had for some time been under the care of local conjurers, who, failing to relieve by their incantations, demanded a great powpow that should embrace the most noted of the fraternity; they assumed that their failure was due to insufficient *power*, since a half-dozen or more of malevolent spirits were implicated in the production of the malady.

The poor fellow was finally introduced into our midst, when he was submitted to a searching cross-examination as to forgotten or unfulfilled vows; then, after a few uneventful preliminaries, such as looking into amulets in order to determine the number and character of the demons involved, he was placed in the center of the circle of conjurers who had thus ranged themselves to the left of the fire.

Pou-ni-ka-ma-ta, the "Medicine Elk," he of the antlered head, led the jig, circling round and round the invalid, followed by the entire conjuring crew in single file chanting a refrain that ever ended with a line indicative of the unity of purpose and power of the Supreme Manitou on earth, giving a peculiar inflection and intonation to the final word. This was repeated over and over and over again, with unvarying monotony, only to be replaced after a measured period by another higher in key, and more emphatic in enunciation and movement; and

* "Medicine," in its savage sense, admits of no change in orthography, whether used in the singular or plural, or as a verb, adverb, noun, or adjective.

this in turn gave way to a third that embodied still more prominently the peculiarities of the last. During all this marching the performers, each and severally, at varied intervals, cast into the blaze articles taken from their "medicine-bags" or amulet-pouches, offerings that consisted for the most part, as our olfactories afforded abundant evidence, of shreds of skins, bits of bone, horn, hair, and other animal matters, selected without regard to uniformity, but in accordance with the taste or fancy of the individual through some act or incident that was supposed to imbue the same with "medicine."

Turn and turn about these chants were repeated to a running accompaniment of drums, rattles, and bells in the hands of the acolytes or apprentices seated at the opposite side of the fire for the purpose, and who varied their music in accordance with the rise and fall of the voices of their superiors, now and again instituting foul scents on their own account, or chorusing the din with responsive shrieks and howls.

In this way the powwow was carried on for an hour or more, when the entire chorus came to an abrupt stand, and with a final flourish of instruments face inward toward the sufferer. With another flourish each stretched forth his right arm, the hand holding the sacred medicine-bag, which was directed point-blank at the object of conjuration, a position that was maintained so long that it caused my arm to ache through sympathy. And then the leader uttered a sharp and authoritative "*Hugh!—begone!*" when march and tune were resumed as before.

Three times these ceremonies were gone over in all detail, and three times the obnoxious spirits were bidden to depart. Then, in response to queries propounded by *Pou-ni-ka-ma-ta*, the sufferer admitted some little benefit—that sensation was in some measure restored, or, as he expressed it, the arm felt as if awakening from a "big sleep."

Simultaneously with the expiration of the ninth series of ceremonials and the final "Begone!" the poor paralytic became animated by a species of ecstasy, as it were, and sprang into the air several times in rapid succession, whirling the maimed member around his head violently with apparently perfect command, at the same time uttering blood-curdling yells and screeches: then fell to dancing violently to music of his own improvising, more remarkable for volume and pitch than for harmony or sentiment; conducting himself for all the world as if possessed by an infinite number of those gentry that, in Scriptural times, were accredited with an unusual and somewhat precarious fondness for pork.

No one interfered. Indeed, all appeared to regard the matter as one of course. And when the poor crazed paralytic sank to the ground exhausted and helpless, frothing at the lips and every muscle tense and spasmodically twitching and quivering, not a hand was lifted for his resuscitation; after a few moments' gazing, audience and performers

dispersed, while the friends of the unfortunate merely lifted and carried him to his lodge, and there left him alone, to recover or die as the case might be. Justice compels me to add, however, that this apparent stoicism was not so much the result of indifference as of the fact that the man was esteemed "medicine," and hence should not be meddled with; any interference might not only be fatal to the spell that had been worked, but would jeopard the welfare of the individual, bringing the wrath of the spirits upon his own head! *

I visited the subject of conjuration the day following, and found him up, "clothed and in his right mind." Accepting an invitation to a seat beside him, conversation soon turned on the events of the night before, when he assured me, and I presume truthfully, that he had no remembrance of what had occurred subsequent to the moment he announced the partial restoration of sensation, until in the gray of the morning, when he awoke to find himself reclining on the skins in his own lodge. I also availed myself of the opportunity offered for investigation, when I found, much to my amazement, that, save for a slightly atrophied condition of the diseased side, the two halves of the body were coequal in sensation and control. He was confident that permanent relief had been obtained, which I was by no means willing to concede, though I kept my opinions strictly to myself. Subsequently my diagnosis and prognosis were confirmed by a return of the malady, which became even more assertive than before: for now the leg, which before had been in a degree amenable to the will, became perfectly unmanageable, and even the muscles of the face were rigidly set. When I left the neighborhood, a second powwow was proposed, to be conducted on a still grander scale; but I have no means of knowing more of the case or its subsequent treatment. There were, however, reasons convincing to any qualified medical man why there should be no permanent change save for the worse: the case was simply incurable.

One conjurer, whom I knew intimately, and whose adopted brother I was, surpassed by far the most able and expert of the civilized exponents of necromancy. *Wa-ah-poos*, or "The Rabbit," as he was mellifluously known, would perform the most difficult and astounding feats at an instant's notice, regardless of preparation or surroundings. He would allow himself to be bound hand and foot with rawhide thongs, even the whole body enveloped, pinioning the arms and hands to back and sides, yet the very instant a blanket or robe was cast over him he would bound to his feet free, with the bonds gathered in his hands, with the fastenings thereof intact. Once I bound his naked form with powerful strips of green moose-hide, drawing them so tightly that the blood threatened to burst from the ridges of unimprisoned flesh; but it made not the least difference so far as I could discover. On another occasion, in the middle of the day, he was even more elaborately pin-

* Mark the analogy to the demonology of the early Christian era and of the New Testament.

ioned—wound and rewound until he appeared an improvised mummy—employing knots and turns innumerable, such as had been suggested by naval experience; and he passed from my hands only to be lifted into a small tent or "medicine-lodge" erected for the purpose in the midst of an open prairie, which was devoid of all furnishings save a rattle and drum suspended from the interlocking poles at the apex. Scarcely was he concealed from view, however, when both instruments began a low accompaniment to a chant he sang, and the air all about became vocal with a multitude of noises and sounds, some high overhead, some apparently far away, and others in the grass at our feet; and these sounds were not heard singly and in succession, but altogether in one chorus: bisons bellowed, bears growled, wolves howled, wapiti stags roared, frogs croaked, deer stamped and whistled, horses neighed and galloped, dogs and foxes barked, serpents rattled and hissed, squirrels and hares squealed and rustled, the cat tribe spat and swore, and even wild-fowl flapped their wings and uttered their accustomed cries—a feat of ventriloquism, if ventriloquism it was, and I can assign no other cause, unparalleled in all my experience. When the uproar subsided, *Wa-ah-poos* appeared at the entrance of the tent unbound; but the thongs, for which most thorough and diligent search was made, were missing. Calling to him an Iroquois, an utter stranger to all but myself, who had arrived but the day before from beyond the Great Lakes in the province of Ontario, he directed him to a certain tree he pointed out growing on a bluff more than a mile away, bidding him bring what would there be found suspended from a designated branch. The latter, much to the general amazement, returned with the bonds apparently intact; and were I not assured of the impossibility of transporting them to that distance, I should have had no hesitancy in making affidavit that they were those with which the conjurer had been bound, so exactly did every turn and knot appear to be my very own.

A few days later, the same wizard, while conjuring a squaw in the final stage of phthisis (consumption), suddenly thrust his hands beneath the blanket that covered her emaciated form, and dragged forth the carcass of a full-grown gray wolf, which he flung outside into the midst of assembled relatives and friends, by whom it was quickly pounded and trampled into an almost unrecognizable pulp. "The Rabbit" now announced the recovery of the woman as assured. In making this assertion, however, he was "a trifle out," since she died the same night! I had warned him of the probable result, but he responded that it "mattered little." It evidently was not his first experience of the kind, and he found ready excuse in another spirit, a near relative of the first, who had returned unexpectedly from a long journey, and whose presence consequently could not have been foreseen, who took advantage of his (*Wa-ah-poos's*) temporary absence to work its foul purpose!

How the old rogue managed to duplicate the bonds so cleverly and place them in the tree before a knot had been placed in the original, is a problem I leave others to solve, though to my mind it is not so difficult as might be imagined. But how or where he obtained his dead wolf is entirely beyond my conjecture. There was no wolf beneath the blanket five minutes before it came to light, for I had but just given the sufferer a careful examination, and could not have failed to detect its presence. There was but one other occupant of the lodge besides the patient and ourselves—the husband—and he sat too far away for collusion. He had not moved for more than an hour, and no one had passed in or out for double that period of time. The violence of the conjurer's exertions had reduced his apparel until it rivaled that of the historic Georgia major; and a breech-clout and medicine-bag would scarce account for anything larger than a small rodent. There was no available place of concealment: then where *did* it come from?

Subsequently I questioned *Wa-ah-poos* upon the subject, but he would give me no other satisfaction than might be derived from a series of baboonish chuckles and grins, and a repetition of the words, "Medicine—big medicine!"

THE ANTARCTIC OCEAN.

By JOSEPH F. JAMES.

THE Antarctic Ocean occupies a position around the south pole similar to that of the Arctic Ocean at the opposite end of the earth. It fills all the space to the south of the Antarctic Circle. It differs vastly, however, from its northern homologue, for, instead of having land at its outer circumference, it has water. While the North American, the European, and the Asiatic coasts encircle the Northern Ocean, the Pacific, the Atlantic, and the Indian Oceans mingle their waters with those of the frozen zone at the south.

As it differs in physical conditions, so also it differs in having received much less attention from the world at large. While the aim of innumerable expeditions for the past four hundred years has been to find a northwest passage to Asia, to plant a flag at latitude 90°, or to rescue some unfortunate commander and his crew from a horrible fate, and while thousands of dollars have been expended, and hundreds of lives have been lost, there is a strange contrast offered when we turn to the far south. The expeditions which have been sent out by the great nations of the world to explore the vast watery expanse about the southern pole are so few as to be counted on the fingers of one hand, and all the ships which have left records of any extensive explorations beyond the Antarctic Circle might be counted on the fingers of two hands. And yet "within the periphery of the Antarctic

Circle," says Lieutenant Maury, "is included an area equal in extent to one sixth of the entire land-surface of our planet. Most of this immense area is as unknown to the inhabitants of the earth as the interior of one of Jupiter's satellites. . . . For the last two hundred years the Arctic Ocean has been a theatre of exploration; but, as for the Antarctic, no expedition has attempted to make any persistent exploration, or even to winter there." It is noteworthy, too, that in the voyages which have been made not a ship nor a life has been lost south of the circle. "It does not appear," says one writer, "that Antarctic voyages would be attended with any excessive degree of danger. . . . It may even be found that the Antarctic barriers are impenetrable; but this has certainly not as yet been demonstrated."

In consequence of this limited exploration, comparatively little is known of the physical condition of this part of the globe. It has been conjectured that a vast continent exist in it. But, if it is there, only mere outlying parts of it have been seen, and those that are known are of such a character as to preclude their being of any value to the world. "Consider for a moment," says Captain Hogg, in his account of the second voyage of Captain Cook, "what thick fogs, snows, storms, intense cold, and everything dangerous to navigation, must be encountered by every hardy adventurer; behold the horrid aspect of a country impenetrable by the animating heat of the sun's rays; a country doomed to be immersed in everlasting snow! See the islands and floats on the coast, and the continual falls of the ice-cliffs in the ports; these difficulties, which might be heightened by others not less dangerous, are sufficient to deter any one from the rash attempt of proceeding farther to the south than our expert and brave commander has done, in search of unknown countries, which, when discovered, will answer no valuable purpose whatever."

The discoveries of Gheritk, Cook, Weddell, Bisco, D'Urville, Wilkes, and Ross—and, if to these we add the Challenger Expedition, we have the whole number of explorers—have revealed the existence of a certain amount of land within the Antarctic Circle. In the year 1600 Theodoric de Gheritk was driven during a gale as far as 64° south latitude, and reported land in that neighborhood. In his second voyage, Captain Cook penetrated during the summer seasons of 1773–'75 to 71° south without finding land previously reported in certain districts; yet he, as well as most of the earlier geographers and navigators, believed firmly in the existence of a southern continent, of little use, as he supposed it to be, for "the ice that is spread over this vast Southern Ocean must originate," in Cook's opinion, "in a track [tract] of land . . . which lies near the pole, and extends farthest to the north opposite the South Atlantic and Indian Oceans; for, ice being found in these farther to the north than anywhere else, . . . land of considerable extent must exist near the south."

This land was largely conjectural until the expeditions sent out by

the French, American, and English Governments under D'Urville, Wilkes, and Ross, respectively, between the years 1838 and 1840. D'Urville left the Strait of Magellan in January, 1838, with two vessels. He penetrated with great difficulty the ice-fields which surround the pole, and reported land as lying about two hundred miles south of the Orkney Islands. The next year he attempted to explore from an opposite quarter, and reported a further discovery which he called Adelia's Land. It seems probable that most of his discoveries were only huge cliffs of ice, though he is said to have landed on a little islet off the coast in one place, and carried away quartz and gneiss rocks torn from the cliffs. He coasted along the ice-cliffs for a distance of more than one hundred miles, and thus describes their appearance:

"The walls of these blocks of ice far exceeded our masts and rigging in height; they overhung our ships, whose dimensions seemed ridiculously curtailed. We seemed to be traversing the narrow streets of some city of giants. At the foot of these gigantic mountains we perceived vast caverns hollowed by the waves, which were there ingulfed with a crashing tumult. The sun darted his oblique rays upon the immense walls of ice, making them look as if they were crystal, and presenting effects of light and shade truly magical and startling. From the summit of these mountains numerous brooks, fed by the melting ice produced by the summer heat of a January sun in these regions, threw themselves in cascades into the icy sea. Occasionally these icebergs would approach each other so as to conceal the land entirely, and we could only perceive two walls of threatening ice whose sonorous echoes sent back the word of command of the officers. The corvette which followed the Astrolabe appeared so small, and its masts so slender, that the ship's crew were seized with terror. For nearly an hour we only saw vertical walls of ice."

Wilkes, as the commander of the American expedition, charted lands which subsequent navigators failed to find. The Challenger sought in vain for what he named Termination Land, but could find only open sea. He explored the ocean for a distance of fifteen hundred miles east and west, skirting a barrier of ice often one hundred and fifty feet or more in height, and sometimes extending in an unbroken line for fifty miles.

Lastly, Sir James Ross, the commander of the English expedition, penetrated from an opposite quarter to Wilkes, and in the same year, and succeeded in reaching latitude 78°, the highest before or since attained. He found a continent which he called Victoria Land, and he describes its first appearance as follows: "On January 11, 1841, in about latitude 71° south and longitude 171° east, the Antarctic Continent was first seen, the general outline of which at once indicated its volcanic character, rising steeply from the ocean in a stupendous mountain-range, peak above peak enveloped in perpetual snow, and clustered together in countless groups resembling a vast mass of crys-

tallization, which, as the sun's rays were reflected on it, exhibited a scene of such unequaled magnificence and splendor as would baffle all language to portray, or give the faintest conception of. One very remarkable peak, in shape like a huge crystal of quartz, rose to the height of 7,867 feet, another to 9,096, and a third to 8,444 feet above the level of the sea. From these peaks ridges descended to the coast, terminating in bold capes and promontories. . . . On the 28th, in latitude 77° 31′ and longitude 167° 1′, the burning volcano, Mount Erebus, was discovered, covered with ice and snow from its base to its summit, from which a dense column of black smoke towered high above the other numerous lofty cones and crateriferous peaks with which this extraordinary land is studded from the seventy-third to the seventy-eighth degree of latitude. Its height above the sea is 12,367 feet, and Mount Terror, an extinct crater, near to it, . . . attains an altitude little inferior, being 10,884 feet in height, and ending in a cape, from which a vast barrier of ice extended in an easterly direction, checking all further progress south. This continuous perpendicular wall of ice, varying in height from two hundred to one hundred feet, its summit presenting an almost unvarying level outline, we traced for three hundred miles, when the pack-ice obstructed all further progress." *

From 1841 up to 1874 when the Challenger visited the Antarctic Circle, no vessel has spent any lengthy period in this region ; so, having thus reviewed the discoveries of the various explorers, let us turn to that element which is so much more abundant than land, the water, and examine its form in a solid state. The icy barrier of which we hear so much is thus described by Sir James Ross : "As we approached the land, . . . we perceived a low white line extending from its extreme eastern point as far as the eye could perceive to the eastward. It presented an extraordinary appearance, gradually increasing in height as we got nearer to it, and proving at length to be a perpendicular cliff of ice between 150 and 200 feet above the level of the sea, perfectly flat and level at the top, and without any fissures or promontories on its even seaward face." This barrier extended for a distance of 450 miles, and nowhere was there any opening of consequence by which it could be penetrated.

Where such immense quantities of solid ice exist, there are icebergs in abundance. The ones floating in these seas are of enormous size, and present a vastly different appearance from those seen at the north. There they are commonly jagged and sharp-pointed from their first leaving the parent glacier, afterward assuming all sorts of weird shapes. But at the south they are at first, and for a long while afterward, flat-topped, with square-cut sides, and with a stratified structure. The top stratum is from ten to twelve inches thick. The thickness of the strata gradually decreases toward the bottom, and at the

* Quoted in Somerville's "Physical Geography," London, I, pp. 282–284.

level of the water is not more than two inches. A line of clear, blue ice marks the boundary of each layer, produced, in the opinion of various writers, by the melting of the top portion of the snow-fall of a previous winter, while the white part represents the unmelted part of the snow-fall. Wilkes estimates the snow-fall in this region at thirty feet in the year, and, as only a very small part of this can be melted in the course of the short summer, an immense accumulation must go on. The small part of each year's fall that is melted will be clear ice, and this is represented by the line of blue in the berg; so that, by counting the number of layers in a berg, some idea can be had of its age.

Sir Wyville Thomson says that the reduction in thickness of the layers from top to bottom is due mostly to compression, and estimates that at a depth of 1,400 feet enough heat will be generated to melt the ice. On the other hand, Croll contends that the temperature of the bottom of the immense icebergs, which sometimes tower 700 and 1,000 feet above the water, is 20° or 22° Fahr., and when we remember that ice floats with from six to seven times its height below water, and that the bottom of a 1,000-foot berg would be 6,000 or 7,000 feet below the surface, it is easily seen that no melting would occur on the bottom of an ice-sheet only 1,400 feet thick. The reason assigned by Croll for the gradual thinning of the ice-layers toward the bottom is, that, instead of being due solely to compression, it is due mainly to what he terms dispersion. In other words, if, at 85° south, a mass of ice covers one square foot of surface, it will, in its gradual passage north, be made to cover two square feet at 80° latitude; at 70° it will occupy four square feet, and, at 60° south, six square feet; that is to say, a stratum which was one foot thick in 85° latitude will be only two inches thick when it has reached 60° latitude.

The discharge of icebergs from the extremity of the ice-field takes place constantly, and they are sometimes huge. Croll has collected notices of bergs which towered 400, 580, 720, 960, and 1,000 feet above the sea-level, and, as six or seven times the bulk above water floats below, some adequate idea can be formed of the contents of a berg three, four, or five miles in length. As the ice-field must have an onward motion to cause this discharge, it has been calculated that one foot in 211 is the smallest slope which will be effectual, and that the ice moves here at the rate of about one quarter of a mile per annum. As it is impossible that thirty or forty feet of snow can be melted in a single short summer's season, it follows that there must be a rapid accumulation all the time. This accumulation will probably be greatest at the pole, and Croll estimates that here the ice has attained a thickness of about seven miles. Allowing this estimate to be correct, and it does not seem excessive, when it is remembered that the thickness of the ice-sheet over Northern New England, during the Glacial period, was 6,000 feet, the question arises, Upon what sort

of land is this immense mass of ice piled? It is a question not easy to answer definitely, because no one has ever seen it. The idea has generally been that the continent is high land. But it has been urged with justness that, had the glaciers descended from a mountainous country, they would bear upon their surfaces, or in their mass, stones to indicate the sort of rock of which the mountains were made. But such is not the case. It is said that stones are never found on the Antarctic bergs, and Captain Cook states expressly his idea that the bergs are formed at the mouths of rivers or cataracts, "because we never found any of the ice which we took up in the least incorporated or connected with earth." He goes on to say: "The ice-islands . . . must be formed from snow and sleet consolidated, which gather by degrees, and are drifted from the mountains. In the winter, the seas or the ice-cliffs must fill up the bays if they are ever so large. The fall of snow occasions the accumulation of these cliffs, till they can support their weight no longer, and large pieces break off from these ice-islands. We are inclined to believe that these ice-cliffs, where they are sheltered from the violence of the winds, extend a great way into the sea."

The discovery, by Sir James Ross, of the Parry Mountains and Mounts Erebus and Terror, in latitude 78°, tended to confirm the prevailing notion of a high and mountainous land forming the Antarctic Continent. But the Parry Mountains are merely conjectural, having been seen only at a distance, and it is well known that the coasts charted by some navigators have been proved by subsequent ones to have been either clouds merely or else islands of ice. The most recent idea is, that the land about the pole consists of a cluster of low islands, rising but little above the sea-level, but united by masses of ice. The gradual accumulation of snow for centuries has raised a cap, as before stated, seven miles thick, and from this cap the ice flows away in all directions, forced onward by the pressure of the enormous mass behind.

The immense size of the icebergs seen in the Antarctic Ocean is without a parallel elsewhere. Croll in a late essay gives a list of the largest of which there is record, and we find they range from 400 to 1,000 feet above the water. The one 1,000 feet high was observed in latitude 37° 32′ south, and was nearly five miles long. When these bergs are first broken off and float away they all have the tabular form, but, as they grow old and drift northward into warmer airs and waters, they become fissured and seamed in all directions; pinnacles and domes and caverns appear, and they become beautiful objects. Wilkes describes one as exhibiting "lofty arches of many-colored tints, leading into deep caverns open to the swell of the sea, which, rushing in, produced loud and distant thunderings. . . . Every noise on board, even our own voices, reverberated from the massive and pure white walls. These tabular bergs are like masses of beautiful ala-

baster. . . . If an immense city of ruined alabaster palaces can be imagined, of every variety of shape and tint, and composed of huge piles of buildings grouped together, with long lanes or streets winding irregularly through them, some faint idea may be formed of the beauty and grandeur of the spectacle."

Dredging and trawling in the Antarctic Ocean have not been extensive. The Challenger Expedition penetrated to 66° south latitude, and dredged and sounded frequently. The temperature of the surface-water ranged from 29·5° to 34·5°, while at 200 fathoms it varied from 30° to 35·5°. Wherever the dredge or trawl was used, quantities of stones, rounded and polished, of basalt and other rocks, were brought to the surface, dropped to the sea-bottom, presumably by icebergs. Life is not abundant, but what exists seems related to that of the northern ocean. Ross, in 1840, dredged in 1,626 feet in latitude 73°, and found several forms of life, of which he says: "It was interesting among these creatures to recognize several that I had been in the habit of taking in equally high northern latitudes; and, although contrary to the general belief of naturalists" (quite modified in the past ten years, however), "I have no doubt that, from however great a depth we may be able to bring up the mud and stones of the bed of the ocean, we shall find them teeming with animal life; the extreme pressure at the greatest depths does not appear to affect these creatures. Hitherto we have not been able to determine this point beyond a thousand fathoms, but from that depth several shell-fish have been brought up with the mud" (volume i, page 202).

SOME ECONOMICS OF NATURE.

By Dr. ANDREW WILSON.

AMONG the views of living Nature, and indeed of the inorganic universe as well, which receive tacit acceptance and sanction from ordinary thinkers, there are certain phases deemed incontrovertible in their plain, every-day demonstration. Before our eyes, for instance, we see *Madre Natura* spending her wherewithal in apparent thriftlessness and woful waste. The proverb, "Waste not, want not," so thoroughly and repeatedly dinned into youthful ears, would seem to have no application to the works and ways of the prodigal All-mother that surrounds and encompasses us. The flower that "blooms unseen and wastes its sweetness on the desert air" is a very mild illustration of a nature-spirit which appeals in more forcible ways to the mind as an example of needless contrivance, wasted effort, and useless prodigality. We fly to Tennyson for that apt quotation concerning the fifty seeds produced, and whereof only one comes to the full fruition of its race. Every summer day shows us how true apparently the

poetic axiom holds. Every spring-time seems to teach us the same truism. The pines and other cone-bearing trees discharge their pollen or fertilizing matter in clouds. The winds, as Nature intends, sweep this pollen from their branches, on the "flowers" of which it has been produced. Carried through the air for miles, so much of the pollen-cloud will fall on the receptive "cones," fertilize the ovules, and thus convert them into seeds, whence a new dynasty of trees may arise. But countless showers of pollen are spent in vain, irrecoverably lost, and sent abroad to no purpose whatever. They fall on barren ground; they litter the earth miles away from their parent trees, or cover the surface of lakes for miles with a yellow film—their purpose futile and their production vain. True it is, as the botanist will tell us, that more pollen must be produced in the case of wind-fertilized plants than is found in that of insect-impregnated flowers. It is a case of "hit or miss" with the wind-fertilized trees, while it is an illustration of an exact calculated aim with the flowers. Hence Nature has to provide for the contingency which awaits her efforts in the former instance by providing a very copious supply of pollen. She is in the position here, not of the marksman who takes deliberate aim at the bull's-eye with his rifle and single bullet. Contrariwise, she uses her Gatling gun or her mitrailleuse in the act of fertilizing the trees. She showers her bullets at the object in the hope that some of them will hit, and with the equally plain expectation that many must miss altogether. The whole process appears to be wasteful in the extreme, natural affairs notwithstanding, and the Tennysonian couplet is practically realized when the spectacle of tons of wasted pollen is beheld, discharged as these are at the mercy of any wind that blows, and sent into the air to accomplish hap-hazard what in other plants is often effected by deliberate and carefully calculated mechanism.

The notion that Nature possesses any system of economics at all might well be questioned by the observer who discerns the apparent waste through which many natural works and ways are carried out. But here, as in the case of so many other phases of life, the two sides of the medal must be carefully studied. It is not the case that Nature is uniformly neglectful of her resources, any more than it is correct to say that she is always saving or perennially economical. Circumstances alter cases in the phases of natural things as in human affairs, and we may readily enough discover that in several instances a very high degree of well-calculated prudence and foresight, speaking in ordinary terms, is exercised in the regulation of the universe of living and non-living things alike.

Take, as a broad example of the close adjustment of ways and means to appointed ends, the relationship between animals and green plants in the matter of their gaseous food. That the animal form demands for its due sustenance a supply of oxygen gas is, of course, a primary fact of elementary science. Without oxygen, animal life

comes to an end. This gas is a necessary part of the animal dietary. It supplies the tinder which kindles life's fuel into a vital blaze, and in other ways it assists not only the building-up but the physiological "breakdown" of the animal frame. Part of this "breakdown" or natural waste accompanying all work, like the inevitable shadow, consists of carbonic-acid gas. This latter compound is made up of so much carbon and so much oxygen. It arises from the union of these two elements within the body, and is a result of the production of heat, representing, in this way, part of the ashes of the bodily fire. Viewed as an excretion, as a something to be got rid of, and as a deadly enough element in the animal domain, this carbonic acid is a thorough enemy of animal life. It is not only useless in, but hurtful to, the animal processes. Ventilation is intended as a practical warfare against the carbonic acid we have exhaled from lungs and skin; and "the breath, rebreathed," is known to be a source of danger and disease to the animal populations of our globe. Here, however, the system of natural economics appears to step in and to solve in an adequate fashion this question of carbonic acid and its uses. Just as the chemist elaborates his coal-tar colors from the refuse and formerly despised waste products of the gas-works, so Dame Nature contrives a use for the waste carbonic acid of the animal world. She introduces the green plants on the scene as her helpmates and allies in the economical work. Every green leaf we see is essentially a devourer of carbonic-acid gas from the atmosphere. That which the animal gives out, the green plant takes in. Not so your mushrooms and other grovelers of the vegetable kingdom, which, having no green about them, refuse to accept the cast-off products of the animal series, and despise the carbonic acid as a poor but proud relation discards the gift of our old garments. The green plant is the recipient of the animal waste. The leaves drink in the carbonic acid which has been exhaled into the atmosphere by the tribes of animals. They receive it into their microscopic cells, each of which, with its living protoplasm and its *chlorophyl* or green granules, is really a little chemical laboratory devoted to the utilization of waste products. Therein, the carbonic-acid gas is received; therein, it is dexterously split up, "decomposed," as chemists would have it, into its original elements, carbon and oxygen; and therein is the carbon retained as part of the food of the plant, while the oxygen, liberated from its carbon bonds, is allowed to escape back into the atmosphere, to become once again useful for the purposes of animal life.

There would thus appear to be a continual interchange taking place between the animal and plant worlds—a perpetual utilization by the latter of the waste products of the former. It is immaterial to this main point in natural economics that the reception of carbonic acid by green plants can only proceed in the presence of light. It is equally immaterial that by night these green plants become like ani-

mals, and receive oxygen (an action which, by the way, they also exhibit by day), and emit carbonic acid. These facts do not affect the main point at issue, which is the direct use by the plant of animal waste, and a very pretty cycle of operations would thus appear to have been established when botanical research showed the interactions to which we have just alluded.

Going a step further in the same direction, we may find that this utilization of animal waste is by no means limited to the mere reception and decomposition of carbonic-acid gas by green plants. It may be shown that the economical routine of Nature is illustrated in other phases of the common life of the world. The general food of plants is really animal waste. We fructify our fields and gardens with the excretions of the animal world. The ammonia which plants demand for food is supplied by the decay of living material, largely animal in its nature; and even the sordid fungi flourish amid decay, and use up in the system of natural economy many products for which it would be hard or impossible to find any other use. What we, in ordinary language, term "putrefaction" or "decay," is really a process of extermination of the decomposing matter. No sooner does an organism —animal or plant—part with vitality and become as the "senseless clod," than thousands of minute organisms—the "germs" of popular science—make it their habitation and their home. The process of putrefaction, unsavory as it may be, is really Nature's way of picking the once living body to pieces, of disposing of it in the most economical way. So much of it is converted into gas, which, mingling with the air, feeds the green plants as we have noted. So much of the dead frame is slowly rendered into nothingness by the attack of the microscopic plants which are the causes of decomposition. Nature says to these lower organisms: "There is your food. In nourishing yourselves, accomplish my further work of ridding the earth of yon dead material." And so much, lastly, of the once living frame—assuming it to have been that of the higher animal—as is of mineral nature, and therefore resists mere decay, will in due time be dissolved away by the rains and moisture, and be carried into the soil, to enter into new and varied combinations in the shape of the minerals which go to feed plants. Shakespeare must surely have possessed some inkling of such a round of natural economics when we find him saying:

> "Imperial Cæsar, dead and turned to clay,
> Might stop a hole to keep the wind away:
> Oh, that that earth, which kept the world in awe,
> Should patch a wall t'expel the winter's flaw!"

Continuing the study, we may see yet further glimpses of the great system of general regulation which guards Nature from overdrawing her accounts in connection with the arrangement of living things. Not only in beings of high degree, but in animals of low estate, do we meet with illustrations of the economy of power and the

saving of needless expenditure of force and energy which Dame Nature practices. The study of human anatomy, which of course is one in many points with the comparative science as applied to lower life, reveals not a few instructive examples of this saving tendency in life's ways. The human head, for example, is nicely balanced on the spine. Compared with heads of lower type, this equipoise forms a prominent feature of man's estate. The head-mass of dog, horse, or elephant requires to be tied on, as it were, to the spine. Ligaments and muscular arrangements of complex nature perform their part in securing that the front extremity of these forms should be safely adjusted. But in man there is an absence of effort apparent in Nature's ways of securing the desired end. The erect posture, too, is adjusted and arranged for on principles of neat economy. The type of body is the same as in lower life. Humanity appears before us as a modification, an evolution, but in no sense a new creation. Man rises from his "fore-legs"—arms being identical, be it remarked, with the anterior pair of limbs in lower life—and speedily there ensues an adaptation of means to ends, and all in the direction of the economical conversion of the lower to the higher type of being. The head becomes balanced, and not secured, as we have seen, and thus a saving of muscular power is entailed. Adjustments of bones and joints take place, and the muscles of one aspect, say the front, of the body, counterbalance the action of those of the other aspect, the back; and between the two diverging tendencies the erect position is maintained practically without effort. So, also, in the petty details of the work, Nature has not been unmindful of her "saving clause." We see this latter fact illustrated in the disposition of the arrangements of foot and heel. One may legitimately announce that man owes much to his head; but the truth is he owes a great deal of his mental comfort and physical economy to his heels. The heel-bone has become especially prominent in man when compared with lower forms of quadruped life. It projects far behind the mass of foot and leg, and thus forms a stable fulcrum or support, whereon the body may rest. Here, again, economy of ways and means is illustrated. There is no needless strain or active muscular work involved in the maintenance of the erect posture in man. It is largely a matter of equipoise, wrought out through a scheme of adaptation which takes saving of power and energy as its central idea.

Physiological research lays bare many other points in human and allied life which bear out the contention and principle that natural economics is a powerful and prevailing reality of life. Muscles are ordered, for example, on the plain principle of single acts and of divided tasks. Thus a man bends his forearm on the upper arm largely by aid of the familiar "biceps." This done, the "biceps" retires from the field of work. The arm is straightened by the action of a different muscle, the "triceps." So, also, with the shutting and open-

ing of the hand. While the "flexors" of the fingers placed on the front palm or surface of the limb close the hand, it is the "extensors" of the opposite aspect of the forearm (whose sinews we see in the back of the hand), which open or extend our digits. There may be multiplication of organs here, it is true ; but, given the original power to produce them, there is a clear economy of vital wear and tear exercised in the avoidance of too onerous tasks being laid upon any one muscle.

It is something of this principle which we find reflected also in the circulation of the blood. Here we see the heart's left ventricle (or larger cavity of the left side) driving blood, as does a force-pump, out into the great system of arteries, which everywhere throughout the body carry the nutrient stream. No sooner, however, has the blood-stream, impelled by the contraction of the muscular walls of the heart's ventricle, passed into the great main artery (the aorta) which arises from the heart, than an economical principle of an important kind comes into play. This principle is represented by the elasticity of the arteries which bear the blood to the body. They possess a circular coating of muscle which diminishes in thickness as the vessels grow smaller and smaller, and are therefore removed from the influence of the pumping-engine of the circulation. The arterial coating is itself elastic, and the whole system of these vessels is thus endowed with a high amount of resiliency. Their internal coats are smooth and shining, as also is the lining of the heart's cavities, friction being thus reduced to its minimum. The united sectional area of the branches of the dividing artery is larger than the same area of its stem, so that the collective capacity of the vessels increases markedly as we pass from the heart outward to the minuter channels of the circulation.

The blood is thus driven through an elastic set of tubes presenting the least possible resistance to the flow of fluid through them, and economy of power is thus again witnessed in the details of the human estate. Nor is this all. That there exists resistance to the flow of blood is, of course, a necessary condition in any system wherein large tubes or arteries branch out into small tubes (the capillaries), and these, again, unite to form larger or return vessels—the veins. The problem of living Nature would here appear to resolve itself into the inquiry, how the apparently intermittent, or spasmodic, work of the heart may be converted into a constant and continuous action.

If we suppose that a pump drives water through a rigid pipe, we see, in such a case, just as much fluid to issue from the pipe's end as entered it at the stroke of the pump. Practically, also, the escape of the water from the pipe takes place almost simultaneously with its entrance therein. If we place some obstacle or resistance to the free flow through the pipe, while the pump acts as before, the quantity of water expelled will be less, because less fluid enters the pipe. Just as

much water will leave the tube as enters it under the two conditions of no resistance and of the presence of such obstacle to the flow. If now we substitute for our rigid pipe an elastic one, the resistance to the water-flow is diminished, no doubt, but the fluid will, as before, issue in jets; that is, in an intermittent and not continuous fashion. There is "easy come and easy go" in the elastic tube, as in the rigid one where no resistance exists. The elasticity, in other words, is not called upon to act in modifying the flow because the course of the fluid is clear and open. Suppose, now, that some obstacle or resistance is introduced into the elastic tube. The fluid can not escape so readily as before, and it tends, as a matter of course, to accumulate on the near or pump side of the obstacle. The tube gives, so to speak, and accommodates the water which is forced to wait its turn for exit. Each stroke of the pump, it is true, sends its quantity into the tube, but between the strokes the swollen and expanded tubes, in virtue of their elasticity, act as an aid to the pump, and by exercising their power force the accumulated fluid past the point of resistance. There is rest in the rigid tube between the pump-strokes. There is, contrariwise, activity in the elastic tube, due to the overcoming by its elasticity of the obstacle to the flow, and to its work of keeping the fluid moving and of avoiding distention and blockage. It is possible, moreover, to conceive of the elastic reaction of the tube being so great that the accumulated fluid will be made to pass the knotty point before the next stroke of the pump occurs. Let us imagine, lastly, that the strokes succeed one another in rapid succession, and that the elasticity of the tube is powerful enough to overcome the resistance opposing the flow of fluid, and we shall arrive at a state of matters wherein not only will the obstacle become practically non-existent while as much fluid leaves the tube as enters it, but the flow from the far end of the tube will also be converted into a continuous and stable stream.

This latter condition of matters is exactly reproduced in the circulation of the blood. There is great resistance found on the arterial side of the heart. Each impulse has to send blood into a vessel which is elastic in itself, as we have seen; but immediately on the first stroke of the heart succeeds a second. Hence the blood accumulates on the heart's side before that propelled by the first stroke has been completely disposed of. Distention and strain of the vessel succeed, and one of two results must follow. Either the circulating arrangements must collapse, or the elasticity of the tubes into which the blood is being perpetually forced will acquire power sufficient to overcome the resistance, and to propel onward the amount of blood with which each stroke of the heart charges the circulation. Here the true meaning of the rapid work of the heart and of the elasticity of the arteries becomes apparent. The otherwise intermittent flow of blood is converted into a continuous stream. The heart keeps the arteries over-distended on the near side of the resistance, while these elastic tubes,

so treated, discharge themselves in turn onward, and at a rate which corresponds to that with which the force-pump action of the heart charges them from behind. And so, tracing the hydraulics of the circulation through its phases we see, firstly, the heart over-distending the elastic arteries. We witness the arteries emptying themselves into their minute continuations, the capillaries, and through these latter into the veins or return-vessels. The economy is witnessed here in the easy means adapted for converting without complications a spasmodic flow of blood into a continuous stream; insuring also that the amount of of blood which flows from the arteries to the veins during the heart's stroke and pause exactly equals that which enters the circulation at each contraction of the ventricle. In other words, the tremendously high pressure of the arteries of our bodies saves at once the multiplication of bodily pumping-engines and conserves the force of the heart itself.

There are other points connected with the circulation, more or less intimately, to which a passing allusion may be made. The low-pressure flow of blood in the veins upward to the heart from the lower parts of the body is thus favored by the high pressure of the arterial system, and natural economy of energy is thus again exemplified. The arteries seem to be intent on the work of getting rid of their contents through the capillaries into the veins. There is no resistance, in fact, to the venous flow which is carried on at low pressure. Again, the ordinary muscular movements of the body are utilized in the economy of life, to favor the return of the venous blood. For the veins are compressed in the muscular movements, and, as they are provided with valves which prevent back-flow, the compression can act in one way only—namely, to aid the upward or backward return of blood to the heart's right side.

The overplus of the blood is known as *lymph*, and is gathered from the tissues by vessels known as *absorbents* or *lymphatics*. These return the lymph to the blood-current for future use. Nature "gathers up the fragments" here as elsewhere, and sees that the lymph or excess of the blood-supply is once more garnered into the vital stream of the circulation. If we ask how this lymph-flow is maintained from all parts of the body toward the great vein in the neck where the lymph joins the blood, we again light upon the question of high pressure in one side of matters and low pressure in the other side. All the ordinary movements of our bodies are economically pressed by Nature into the service of the lymph-flow. As in the veins, the valves of the lymphatics prevent backward movement, and as in the veins the muscles compress the vessels, and common movement thus assists a special end. Even the motions of breathing favor the return of the lymph. For, when we inspire, the pressure in the great veins becomes negative in character, and lymph is thus capable of being sucked into the circulation from the main tube or duct of the lymph-system. When we

"breathe out," the pressure in the large veins increases it is true, but a valve guards the entrance, which in inspiration is free, and untoward consequences are thus prevented. It is a notable fact that in many animals organs known as lymph-hearts are developed. As in the frog, these contractile organs assist the lymph in its return to the circulation. It therefore becomes of interest to note how, in the higher walks of existence, the mechanical contrivances and actions of the body undergo an evolution which not only avoids multiplication of parts and organs, but also conserves and economizes the energy which has to be expended in the maintenance of life.

The function of breathing has been incidentally alluded to in the course of the foregoing remarks, and, in considering the details of this paramount duty of life, we find additional proof of the fact that Nature's economics in higher life are frequently expressed in terms of admirable mechanical contrivance. Primarily, in the case of respiration, we find the bony elements of the chest fitly developed in view of certain physical qualities, of which elasticity forms perhaps the chief. The front wall of the chest is practically composed of cartilage or "gristle." The "costal cartilages," or those of the ribs, intervene between the upper seven ribs and the "sternum" or breast-bone. The eighth, ninth, and tenth pairs of ribs also possess cartilages, but these run into and join the gristly extremity of the seventh pair; while the last two pairs of ribs (eleventh and twelfth) spring from the spine behind, but are not attached in front at all. Essentially, the chest is a bony cage, possessed of high elasticity. Even in the dried skeleton, pressure from above, downward or backward, applied to the front of the chest shows this quality of its structures in a marked fashion.

If we study, even superficially, the mechanism involved in breathing, we may gain an idea of the key-note of the process in so far as economy of force is concerned. "Breathing in," if we reflect upon the nature of the act in our individual persons, is a matter of some trouble. It involves a large amount of labor; it gives us much muscular trouble, so to speak. In the case of a deep inspiration, we exaggerate the effort seen in normal breathing, and we may therefore appreciate still more exactly the expenditure of energy required to carry on this necessary function of vitality. But "breathing out" is a widely different matter. We let the chest "go," as it were, at the close of inspiration, and, without an effort, it returns to its position of rest. We expend force in "breathing in"; we appear to exert none in "breathing out." The former is a muscular act performed by a complex series of muscles, and participated in by the lungs and other structures connected with the chest. The latter is an act which partakes, even to the common understanding, of the nature of a recoil; and in this latter supposition we perceive how economy of labor in the human domain is again subserved.

Breathing, then, means that we enlarge the chest by the action of

certain muscles, that the pressure of air in the lungs becomes reduced as compared with that outside, and that in consequence air rushes into the lungs through the windpipe until an equality of air-pressure inside and outside the lungs is produced. This is the act which is accomplished forcibly, against gravity, and by aid of very considerable muscular power. We are said to perform no less than twenty-one foot-tons of work by means of our respiratory muscles in twenty-four hours—that is to say, the work of these muscles, extending over twenty-four hours' period, if gathered into one huge lift, would raise twenty-one tons weight one foot high.

By a little additional muscular labor we take in a deep breath, still further enlarge the chest, and inhale an additional quantity of air. The great muscle named the diaphragm or "midriff," which forms the floor of the chest, is the chief agent involved in the act of inspiration. It descends, while the ribs are elevated, and, as the chest enlarges, the inflow of air takes place. The lungs themselves are highly elastic bodies. They follow the movements of the chest-walls, and thus expand and contract—they suffer dilatation and compression—as the chest-walls move in the acts of respiration. But, when ordinary "breathing out" is studied, we see that it is as clearly a matter of recoil, as has been stated, as "breathing in" is a matter of exertion. Here elastic reaction steps in to complete the full act of breathing. Nature saves her energies and husbands her strength in this truly physiological division of labor. When we inspire, the lung-substance, elastic in itself, is put on the stretch; the cartilages of ribs and breast-bone are similarly elevated and expanded, and the whole chest is, so to speak, forced into its position of unrest. Then comes the reaction. The muscles of inspiration cease their action; they relax, and the elastic lungs recover themselves and aid in forcing out the air they contain. So, also, when the rib-muscles have come to the end of their tether in elevating these bones, the elastic recoil of the ribs and breast-bone serves to diminish the capacity of the chest, and to further expel the air from within its contained lungs. Labored or excessive breathing, as most readers know, calls into play extra help from muscles not ordinarily used in natural respiration. This fact takes us out of the normal way of life into the consideration of abnormal or diseased states, and demonstrates that the economy of Nature disappears when phases of morbid action fail to be observed. In natural breathing, however, we see conservation once more in the easy recoil which follows the muscular labor of inspiration. The physiology of a sigh and its relief can be readily appreciated on the basis which shows how the easy act of expiration is correlated with the more labored action and duty of enlarging the chest.

A phase of Nature which is by no means foreign to the foregoing illustration of the conservation of power in the human body is presented to us in several aspects of lower life. In the breathing of cer-

tain animal forms, belonging to the *Molluscan* races, we may discover equally admirable examples of economy in natural work. Among the cephalopods or cuttle-fishes we observe such features. Any one who has seen an octopus resting in its tank in an aquarium must have been struck by the puffing and blowing movements of the sack-like body, the nature of which excited Victor Hugo's imaginative powers in the "Toilers of the Sea." The octopus is seen to inspire and expire with great regularity. The soft body expands and contracts rhythmically enough to excite a natural comparison between its respiratory acts and our own. If we could dye the water so that our eye could follow the currents which the octopus inhales and exhales, we should perceive that at each inspiration the soft body expands, and water is drawn in two currents into the neck-openings. These openings lead directly each into a gill-chamber of the animal. Here, inclosed in its own cavity, we find a plume-like gill. In its nature, this structure is simply a mesh-work of blood-vessels, and thus comes to resemble a lung in its essential features. Impure blood—that is, blood laden with the waste materials of the octopus-body, with the products of the vital wear and tear—is driven into the gill on one side. Subjected to the action of the oxygen gas contained in the water breathed in, the blood is purified. Its waste materials are given forth to the water, and it is passed onward out of the gill on its way to the heart for recirculation throughout the cuttle-fish frame.

Breathing in oxygen entangled in the water is, therefore, in the case of the cuttle-fish, an analogous act to that seen in higher animals, which inhale oxygen directly from the air. The octopus, however, performs an expiratory act likewise. Placed below the head is a short tube, named in zoölogical parlance the "funnel." When cuttle-fish inspiration has come to an end, expiration begins. The body contracts, and the water, which a moment before was drawn into the gill-chambers by the neck-openings, is expelled from the "funnel." The openings of entrance are guarded by valves. These close when expiration begins, and the water has no choice save to find a forcible exit by the tube just named. So far, in octopus existence it would seem as though there was no economy of power exhibited in the act of breathing. Muscular action expands the soft body, and muscular force contracts it. There is exhibited here a plain difference between the octopus and the higher vertebrate.

But the story of cuttle-fish economy is not yet completed. A moment more and your octopus, which sat crouched in the bottom of the tank, is seen to wing its way through the water. It skims like a living rocket through the clear medium in which it lives, as if impelled by some marvelous and invisible agency. The secret of this flight is the solution of cuttle-fish economy and reserve force. So long as the resting-mood prevails, the water used in breathing is ejected slowly, or at least without any marked display of force. But when locomo-

tion has to be subserved, and when the cuttle-fish desires to swim, it propels itself through the water by aid of a veritable hydraulic engine. The effete water from the gills is ejected with force from the funnel, and by the reaction of this *jet d'eau* upon the surrounding medium the animal is enabled to execute its aquatic flights. Economy of a very rigid order is illustrated clearly enough in octopod existence. The otherwise useless "breath" of the animal becomes converted into a means of locomotion.

A still closer parallel to the human chest-recoil, perchance, may be found in the case of certain poor relations of the octopus. These lower forms are the mussels, oysters, cockles, clams, and other bivalve shell-fish which frequent our own and other coasts of the world. Incased in its shell, a mussel or oyster, all headless as it is, and possessing in its way a strictly "local habitation," in that it is a fixture of the coast or sea-depth, presents us with the type of an apparently vegetative life. But there is abundant activity illustrated within the mussel or oyster shell. There are millions of minute living threads—the *cilia* of the naturalist—perpetually waving to and fro as they crowd the surface of the gills. These cilia, acting like so many microscopic brooms, draw in the currents of water necessary for food and breathing, while the same incessant movement which draws in the fresh water circulates it over the gills, and in turn sweeps it out as waste material from the shell. The oyster implanted in its bed, or the mussel attached by its "byssus" or "beard" to the rock, exhibits a half-open condition of the shell as its normal state. The animal lives—as may be seen on looking at a tub of oysters as they lie amid their native element—with the shell unclosed for purposes of nutrition and breathing. If, however, we tap the living oyster or mussel ever so lightly, we find the shell to close with a snap that renders the persuasion of the oyster-knife necessary for its forcible unclosure. In such a case the animal's senses, warned of possible danger by the tap on the shell, communicate to its muscular system a nervous command, resulting in a movement which, as regards the oyster, reminds one of nothing so forcibly as the cry and action of "shutters up" in a Scotch university town when snow-balling begins.

The muscular system of these shell-fish is disposed in simple fashion. Look at the inside of an oyster-shell, and note the thumb-like impression you see occupying a nearly central position. This is the mark of the "adductor" muscle of the oyster, or that which draws the shells together. The secret of successful oyster-opening is simply the knowledge, acquired by much practice, of hitting the exact position of the "adductor" muscle, and of dividing its fibers with the knife. The enormous power of this muscle to keep the valves in apposition can be appreciated most readily, perhaps, by the amateur "opener" of these bivalves. In the mussel there are two such "adductors," one at either extremity of the shell, and we note the impressions which these struct-

ures leave on the shell's interior. The latter animal has thus a double hold-fast, whereas the oyster has but a single one. If the function of these structures is thus concerned with the *clôture* aspect of bivalve life, how, it may be asked, is the opening of the shell provided for? This is exactly the point to which Nature directs her energies in arranging her economical disposition of the oyster or mussel constitution. We have seen that the natural and persistent state of oyster-life is a condition of unclosure, while the opposite action of shutting the shell is only a transitory and infrequent phase of bivalve existence at the best. There is afforded a chance for the exercise of mechanical expediency in making the open state of the shell a matter of ease, and one carried out without effort or exercise of energy. And so is it contrived.

Suppose that, placing two oyster-shells in their natural position, we insert a piece of India-rubber between the valves at the point where they are hinged together. If we now forcibly close the shells by pressure, the India-rubber is compressed. When we release the pressure of our fingers, the elasticity and recoil of the India-rubber forces the valves apart. In such a fashion, then, does Nature provide for the constant maintenance of the unclosed condition. The "ligaments" of the shell are natural elastic pads existing at the hinge-line. By their elasticity they keep the valves unclosed. There is no strain involved in the action, which is a merely mechanical one, after all. But when the more infrequent act of closure has to be performed, then muscular energy requires to be displayed. The quick snap of the valves reminds us that muscular exertion, even if necessitating vital wear and tear, has its corresponding advantage in the rapidity and effectiveness with which it provides for protection against the entrance of disagreeable or noxious elements into the internal arrangements of oyster or mussel life. There is illustrated here a clear saving of life-force, and a persistent system of vital economics in the substitution of a mechanical for a muscular strain where the maintenance of the open state of the shell is concerned.

Returning to the human domain for a final glance at our subject, there are found in the spheres of digestive nervous actions many facts and examples proving the exercise of a constant economic surveillance of our life. The digestive duty may be defined as that whereby our food is converted into a fluid capable, when added to the blood, of repairing and replenishing that fluid. To this end, as is well known, the nutriment has to pass along the tube known as the digestive system, and to be subjected to the chemical action of the various fluids or secretions which are poured upon it in the course of its transit. In the stomach, for example, certain important food-principles—those of nitrogenous kind—are first selected as it were from the nutriment, chemically altered by the gastric juice, and rendered capable of being absorbed into the system. Instead of waiting for a lengthened period

for the arrival of this important part of its commissariat, the body receives such food-elements soon after digestion begins. The fats, starches, and sugars are, on the contrary, passed onward to be digested in the intestine. They become available for nutrition only after several hours of digestive work. The principle of "small profits and quick returns"—itself an economical and commercially satisfactory mode of doing business—is illustrated in the digestive transactions of the body. That which is urgently required for the frame is quickly supplied, while the (in one sense) less important foods are left for later absorption.

In this economical work the liver plays an important part. Long ago in physiological history that organ was regarded simply as a bile-making machine. The bile, thrown upon the food just after it leaves the stomach, was regarded as an all-important digestive fluid. To-day we have entered upon entirely new ideas of the liver's work. As Dr. Brunton has aptly put it, the liver is no more to be regarded as a mere bile-maker than the sole use of an Atlantic liner is to be found in the manufacture and display of the water-jets which issue from the sides of the ship as the waste products of her engine-work. The liver is really a physiological constable placed at the entrance of the blood-circulation. Into it are swept digested matters. These are further elaborated and changed so as perfectly to fit them for entrance into the blood. When the functions of the liver are suppressed or rendered inactive, elements of deleterious kind are apparently allowed to enter the circulation, and thus produce all the symptoms of the body poisoning itself. This being so, we begin to see that the bile is really a mere by-result of the liver's work, as the condensed water of the steamer is the consequence of the real function of the vessel. Bile is a waste product, and as such it is discharged into the intestine and thus excreted.

But natural economics rule life's actions here as elsewhere. For the apparently useless bile, Nature finds a use. It is discharged upon the food, and mingles with the half-digested nutriment. It has come to exercise a digestive or dissolving action upon fats, a function aptly illustrated by the household use of the "ox-gall" to remove grease-stains in the house-cleaning periods of human existence. Moreover, the bile would appear to aid in promoting the muscular contractions of the intestine, and in thus expediting digestive action. It may possess other duties still; but enough has been said to show that the economy which rules living functions is probably nowhere better illustrated than in the utilization of bile, as a waste product, in the normal discharge of the digestive act.

Turning, lastly, to the nervous system and its work, we may find exemplified equally manifest phases of economical action. When we reflect upon the fact that higher life is a tremendously complex matter in its nervous and mental phases alone, we may well be tempted to

wonder that we really find time for all the acts involved in the exercise of even our ordinary work. The condition of the brain and nervous apparatus at large might at first sight appear to represent that of an overworked signal-box at an important railway junction. Questions of commissariat, of threatening danger, of demands for information, of difficulties to be cleared away, are perpetually presenting themselves to the nervous apparatus for solution. Yet it is plain that many complex acts, the knowledge of which costs us a deal of trouble to acquire in early life, are not only performed correctly in the absence of all that we may name conscious thought or attention, but are discharged the more efficiently because they are so unthinkingly performed. What we term "automatic" action in human and in lower animal life is only another name for an economical dispensation of bodily work and of the time that work demands for its performance. Reading and writing do not "come by nature," but require to be taught, and from the "A-B-C" stage of the one, the "pothooks-and-hangers" stage of the other, both demanding thought and care, we work our way slowly upward to a phase when we neither need to think about our "p's" and "q's" in writing or our syllables or sounds in reading. In other words, the intellectual operations of early life have become the "automatic acts" of adult existence. The immense saving of nerve-power—or at least of the highest powers we may collectively name "thought"—involved in such an arrangement may readily be understood. We have not even to waste brain-work in the conduct of our steps in walking. We avoid our neighbors and the lamp-posts without concerning ourselves about either. How large a part of our life is automatically ordered, a superficial glance at the history of the nervous system will disclose. The digestion of food, the circulation of the blood, breathing, and many other functions on the due performance and nervous regulation of which the continuity of life depends, are all discharged in this automatic manner.

There is implied herein a large saving of that vital wear and tear of which we have already spoken. Life would indeed be far too short for the safe and satisfactory discharge of the duties of even the humblest life—to say nothing of the performance of merely physical duties of existence—had we to "mark, learn, and inwardly digest" every act in our daily round of labor. We may grumble as we please at overwork, and criticise rightly the evil effects of overstrain; but we should also bear in mind that the nature we own has saved us many a worry and many a pang by the exercise of that system of rigid economy which is traceable, in one form or another, in well-nigh every phase of the life universal.—*Longman's Magazine.*

THE NATURE OF PLEASURE AND PAIN.

By ALFRED FOUILLÉE.

PLATO and Aristotle have well said that neither pure pleasure nor unqualified displeasure exists in man. Both feelings are mixed in unequal proportions by the subtile art of Nature, and the definite impression on our consciousness is a resultant in which one or the other of the elements predominates. The complexity of all emotion may be deduced from the two dominant conceptions of modern physiology. One of them is that our bodies are in reality societies of cells, each of which has its own peculiar activity, and which contend with one another for existence. Among the lower animals each part of the organism appears to enjoy or suffer on its own account, as is exemplified when a worm is cut in two. Among the higher animals a selection and final fusion of the impressions takes place, centering in the brain.

The rudiments of agreeable and disagreeable feeling probably issue from all the parts, and are re-echoed in the general consciousness in such a manner as to communicate to it a timbre of pleasure or pain, according to which elements prevail. Our pains and pleasures would thus be a kind of summary of the elementary affections of a myriad of cells, and our individual comfort or discomfort a collective and social comfort or discomfort. The doctrine of evolution, and of the accumulative effects of heredity in the individual, also confirms this view of the collective character of our sensibility. Not only the present, but the past also, resounds in us; our feelings, even apparently the most novel ones, comprise the unconscious recollection and echo of the experiences of a whole series of ancestors.

Mr. Spencer remarks that the sight of a landscape excites within us certain deep but now vague combinations of states of feeling which were organized in the race during barbarous times, when its pleasurable activities were chiefly among the woods and waters. Mr. Schneider, in his "Freud und Leid des Menschengeschlechts," inquiring why the contemplation of a sunset gives us an impression of calm and peace, says: "There is but one answer: Because for unnumbered generations the view of the setting sun has been associated with the end of the day's work and a feeling of rest and satisfaction." This is saying too much, for the intrinsic effects of the colors and the freshness of the evening air, and our personal recollections, have much to do with these emotions. But it is safe to assume that the calm which the hours of repose have brought to the human race for centuries is reflected in us at the evening hour.

The study of pleasure and pain is thus analogous in complication and difficulty with social science, in which mutual actions and reac-

tions seem, by virtue of their variety and multiplicity, to escape the grasp of calculation. It is not a matter of surprise that philosophers are at variance respecting the nature of these affections. There is hardly a more interesting question before investigators than that of their origin and their office as motive powers in universal evolution. We propose here to examine into what is true and what is incomplete in the explanations of these matters that have been borrowed from the doctrine of natural selection.

We can not fail to apply the biological doctrine of selection to pleasure and pain. Mr. Schneider goes to it for the inmost secret of our joys and sufferings. Not only is there a connection between pleasure and the increase of vitality, but this connection is imperatively established as a necessity of evolution. Pleasure, according to Mr. Spencer, is a feeling which we seek to bring into consciousness and retain there, and pain is a feeling which we seek to get out of consciousness and to keep out. If we could imagine beings to have ever been created by any sport of Nature, whose pleasure was connected with injurious actions and their pains with useful ones, they must have died out speedily by virtue of the vice in their constitutions. According to Darwin's principles, the essential condition of the development of life through ages is that agreeable acts be also, on the whole, favorable to development. This is a mechanical necessity.

Mr. Schneider is so confident of the accuracy of the natural mechanism, at least for the generality of cases, that he is almost ready to believe that Nature is never mistaken when abandoned to herself. "In the normal condition," he says, "the feelings always tend to their true end; errors originate only in the morbid conditions ingrafted upon Nature by civilization. With the natural and healthy man the feelings are healthy, so that with every thought is associated a feeling of corresponding and suitable intensity." Abnormal relations appear chiefly among cultivated men, particularly among those who are diseased by their own fault or by that of their ancestors. "The passions have much less spread in the healthy and simple populations of the country than among the very artificially trained inhabitants of the large cities. Practical right and good conduct are much more dependent on health of the body than on health of the mind."

The exaggerations of the Darwinian theory begin, in our opinion, at this point. A mechanism of pleasures useful to life, once produced, is, without doubt, transmitted by heredity and becomes almost infallible in the lower species; but no infallibility can be found in the higher animals, not even in those that have the *mens sana in corpore sano;* for, the more the organs become complicated, the more does a purely mechanical selection become difficult for them. An idle or unintelligent man, for example, is not hopelessly condemned to death by the justice of universal mechanism, for he has more than one way of escape. If one faculty is under restraint, another one can come to

its help. Moreover, mechanical adaptation to the medium becomes a matter of more difficulty as we ascend in the scale of beings ; and from this arise many anomalies. Individuals retain tastes which were formerly favorable, but are now useless or injurious, as the passion for hunting and the warlike disposition, which are, according to Mr. Spencer, relics of savage instincts. Other anomalies arise in consequence of an antagonism between the individual and the species, as when the lower animals destroy themselves by division to make new beings, and some of a higher grade die immediately after performing the act of reproduction. Mechanical selection is likewise incompetent to give an explanation of the origin of pleasure and pain, and to throw light on their primitive connection with life. We believe that there is a close and strong bond between these affections of life, independent of natural selection, which modifies and perfects the connection, but does not create it, and that we can find the reason of this connection by inquiring of physiology and psychology.

Let us inquire, first, what physiology can teach us about it. In previous investigations in this direction we have reasoned too much from complex organisms already developed. The thing we ought to learn is what, in a cell or a nerve, arouses the rudiment of pleasure or of pain, to be extended ultimately to the whole of the living body. The nervous elements are constantly the scene of a double chemical labor ; a "negative" work of reparation, consisting in the formation of very complex albuminoid compounds ; and a "positive" one of expenditure, consisting in the reduction of these compounds to more simple ones. In the state of repose, these two molecular labors are performed simultaneously, and are nearly in equilibrium. In that case we are conscious simply of a condition of vital calm and evenness, with which is connected a vague feeling of rest and comfort. An external agent, a sound, a light, or a shock, comes to excite a nerve ; the interruption of the equilibrium produces a movement of nervous expenditure, and this excites a simultaneous movement of reparation—just as water flowing out of a siphon-tube calls up into its place water which rises. These two labors are equally necessary to life, and must be suitably proportioned to one another for life to subsist. Nervous reparation, which accumulates force, always has for its result and object exercise, which expends force. In natural selection, the animal can not be satisfied with repairing his nervous system ; he must put it to use, to seek food and defend himself ; he must expend, to preserve. This being so, can we assume, as Léon Dumont does ("Théorie scientifique de la sensibilité"), that the accumulation of force, its "storage in the nerve," is the only cause of pleasure? Every nervous action, says this author, is an expenditure of force. How can expenditure, which is a loss, produce pleasure, the cause of which, on the other hand, is sought in augmentation of force? This view arises from an imperfect conception of the relation of the two molecular labors. The

visible labor of expenditure in walking, speaking, looking, hearing, etc., is doubtless, for the instant, a loss of motive force; but then, as we have just seen, there is in an adequately fed organism reparation of the nerve by nourishment in the measure that it is worn away by exercise. Simple rest is also a sufficient condition of reparation. There is, therefore, no absolutely definitive loss. Furthermore, exercise produces skill in reducing resistances and obstacles; and, when it is moderate and agreeable, it increases and feeds the organ instead of enfeebling it. Want of use, on the other hand, produces atrophy of an organ. Thus, normal exercise, expenditure proportioned to the force, is a necessary condition of reparation, conservation, and progress. Natural selection is therefore a law of work, of incessant expenditure; but the action fortifies, and the expenditure enriches. This means that life supposes incessant recomposition and decomposition, and consequently movements of disintegration as well as of integration. To feel life is to have an obscure perception of all the vital movements; to enjoy or suffer is to feel one's self living more or living less. The more intense the decomposition with an equally intense recomposition, the more precipitous is the vital movement, and the more we feel. It is not, therefore, to adopt the language of mechanics, the potential force, but its transformation into living force and into movement, that causes pleasure—provided the expenditure does not exceed the reparation necessary for the survival of the individual and the species.

Experiment confirms the deductions which are drawn from the laws of natural selection and of the struggle for life. Every normal and proportioned action of a well-fed nerve causes enjoyment; and the pleasure increases with the force of the stimulant to the point where the stimulation and the expenditure which it involves exceed the compensatory labor of reparation. Pain is due to the exhaustion, or the destruction, or the rupture, of the sensitive tissue; disorders which if prolonged would induce the death of the individual or of his posterity. The proportionate or disproportionate exercise of a particular nerve thus extends its effect, by diffusion and sympathy, so that it makes itself felt by the whole of the nervous system, and consequently of the organism. Hence, in the struggle for existence, four situations are possible when considered as to the relation of the expended to the accumulated energy, of the labor produced to the nutrition: 1. An excess of acquisition with insufficient expenditure produces the negative pain of want—the well-fed child suffers from immobility. 2. An increase of expenditure succeeding an increase of nutrition produces the positive pleasure of exercise—the child takes delight in running, jumping, and playing. 3. An increase of expenditure with insufficient reparation produces fatigue and positive pain—a too fast or too long race brings on weariness. 4. Absence of expenditure after exhaustion produces the negative pleasure of rest.

It appears to us that, by a psychological interpretation of physiological facts, these laws can be reduced to one superior and really primitive law. Some have sought the meaning of the law of proportion, which demands that the positive labor of exercise bear a just relation with the negative labor of reparation, in the theory of a just mean, or a kind of golden mediocrity, by which the fundamental law of sensibility would be equilibrium, not action pure and simple. This is confounding the limit of a thing with its essence. Moderation, in itself, is not pleasure, nor the primitive law of life. It is a necessity which life encounters and submits to according to the needs of the organism. The true primary law is that pleasure is connected with the most intense possible activity; and this is, besides, the true condition of superiority in the struggle for existence. For this reason, if the increase of the activity or of the exercised function does not exceed the reserve of forces and wear upon the organ, the pleasure increases with the activity, without regard to moderation. If excess of muscular motion produces pain, it is because, not proportioning our actions to the strength of our organs, we wear upon them. The supposed increase of activity is then really a diminution.

Another problem is met in seeking the reason for the necessity of a change of action, for which contemporary psychologists, like Mr. Bain and Mr. Sully, have propounded the law of contrast as opposed to the laws of stimulation and moderation. It is in reality, however, derivable from the same principle as the other law. Change in action is only a means of assuring continued intensity of action. It makes other nerves to work while the former ones rest, and, effecting a separation of the nerves after this manner, augments the vital power.

To enjoy is, then, to act as much as possible with the greatest intensity, independence, and liberty. Activity, by itself, goes on infinitely. It moderates itself only by necessity and constraint, only to have afterward to moderate itself less, and to deploy itself beyond all the limits successively erected before it.

It might say, with Faust: "If ever I stretch myself, calm and composed, upon a couch, be then at once an end of me. If thou canst ever flatteringly delude me into being pleased with myself—if thou canst cheat me into enjoyment—be that day my last. If I ever say to the passing moment, 'Stay, thou art so fair!' then mayst thou cast me into chains; then I will readily perish; then may the death-bell toll; . . . the clock may stand, the index hand-may fall; be time a thing no more for me."

Activity changes, therefore, only to maintain itself, to adapt itself progressively to the medium which changes, to increase its conquests without losing its acquisitions. In the evolution of species, this expansion of activity has always been a condition of survival and of superiority over other species.

Some authors have maintained that the final intensity of the action

and its victory in the struggle for life are connected with the brute quantity of nervous excitation, independently of its quality. But this view involves difficulties. How, for example, can we explain the fact that some sounds and some odors are disagreeable in all their degrees? Again, fix your eyes upon a moderately lighted white surface; you will feel neither fatigue nor displeasure, but you will also experience only a weak positive pleasure. Substitute a blue surface for the white one. The blue ray, which was previously present in the white light as one of its constituent elements, is now offered separately to your eye, with the other rays eliminated, and your pleasure is increased. The increase of pleasure can not be due to an increase of stimulus, for the physical stimulus has been in fact diminished by the quantity of light that has been eliminated. Your pleasure is no more due to a diminution of fatigue, for there was nothing fatiguing about the white. The agreeable nature of the blue is therefore associated with the mode rather than with the degree of nervous action. An effect of heredity and selection is also involved. Animated beings have for many ages received the blue rays from the sky under which they lived, and they have become hereditarily accustomed and adapted to this luminous medium of clear days as well as to the green rays of the fields and woods. It is, however, impossible to account for the details of our sensory pleasures any more than for our æsthetic pleasures. All that can be said is, generally, that the form or quality of the excitation must be taken account of, as well as its quantity.

If we examine the directions toward which the movements of the organisms ultimately tend, we shall find that some tend to the preservation of the substance, others to its destruction; some to life, others to death. Pleasure is of victory in the struggle, of life, pain of defeat, of death. All suffering is a partial death which comes upon some organ or function. Darkness makes us sad because it extinguishes the sight; discords, because the jangle of noises afflicts our perception of sounds. Thus, everything that tends to obstruct and annul a function of the senses produces annoyance and pain. So with mental functions. We enjoy what we can understand clearly, for it implies life and vigor of thought; we are pained when we fail to understand anything clearly, because that conveys an impression of impotency of thought. The emotion of the sublime involves a mingling of sorrow and joy, because, in the immensity of that which excites it, the possibility of perceiving the whole, of comprehending it all in our eye or even in our imagination, is taken away from us; but, by a superior effort, we conceive the infinite, and annul the material obstacle by the power of thought. We thus, at the same time, feel a physical inferiority that depresses us, and a moral superiority that raises us: we die in the world of sense, and are born again in the world of mind.

While Darwin discusses the struggle for existence, he does not

consider the question of why beings should live, or should desire to live; or why there are agreeable and useful variations which the being should make an effort to preserve. Now, external selection evidently presupposes an internal spring, of necessity or spontaneity, which produces, with life, the bound toward a higher life, the bound of evolution. A German biologist, Mr. Rolph, looked for this spring in the movement of assimilation by endosmose, which is characteristic of all organized beings, or of all individual cells, and which he assumed to be insatiable. In this view, we might then speak of a "mechanical hunger," or craving, as the cause of all the actions of living organisms. Corresponding with this "mechanical hunger" appears, at a particular stage of evolution, what Mr. Rolph calls "psychical hunger," which makes itself felt at first essentially as pain; while pleasure is only "a secondary and derivative phenomenon." Hence it results that pain is the motive spring of the universe. This theory is intimately connected with the doctrine which assumes that the essence of pleasure, or at least its necessary condition, is the suppression of pain. Leibnitz has mentioned those infinitesimal and imperceptible "little griefs" which, being suppressed, give "a quantity of half-pleasures," the continuation and accumulation of which, "as in the continuation of the impulsion of a grave body, which gains impetuosity as it falls," become at last a real and whole pleasure. "And at the bottom," he adds, "without these half-griefs there would be no pleasure, and we should have no means of perceiving that anything aids and relieves us by removing the obstacles that hinder our setting ourselves at ease." An Italian philosopher of the eighteenth century, Verri, developing Leibnitz's thought, came to the conclusion that a pain precedes every pleasure; and the theory has been followed up by Kant and Schopenhauer and the pessimists.

To resolve this question which the pessimists have raised, we must inquire whether there are any pleasures that make themselves felt directly, without the intervention of a previous pain; and whether there can be motives to activity without the assistance of pain. It appears to us that the pleasures of the higher senses, of sight, hearing, and smell, and the mental pleasures, and those of science and art, belong to the latter category. A child, seeing a scarlet cloth for the first time, gains an excitation of the sense of sight which is in no way the suppression of a previous pain. To invoke in this case imperceptible uneasiness and latent wants, and a tension of the optic nerve aspiring to fulfill them, is to form a hypothesis which has a part of truth, but does not wholly explain the phenomena. The pleasure here is not simply the exact filling of a void, or the adequate satisfaction of a pre-existing want; it is a surplus, an addition. If we regard the scale of intensities in sensation, we shall find that there is a point near to indifference, departing from which some pleasures are capable of arising by an increase of intensity. Not every pleasure supposes a previous

descent below the ideal point of indifference into the lower region of pain. Pleasure, then, is felt directly as such, and not indirectly through a pain which it replaces; and the sight enjoys without having suffered.

Modern physiology teaches us that the higher sensibility is connected with special organs, like the eye, the ear, the nose, and the mouth, while inferior sensibility is diffused through the body, without connection with well-differentiated organs. Inferior sensibility informs us of conditions that are material to our existence, as contact, hunger, thirst, etc., and it has been organized through natural selection so as to be alarmed when these conditions are threatened. Hence, inferior sensibility is better adapted to suffering than to enjoyment. The higher senses, on the other hand, particularly sight and hearing, respond less to the needs of life than to superfluity, to conservation than to progress, and are better adapted to pleasure than to pain. It results from this that the mutual relations of enjoyment and suffering are inverse for the higher and the lower senses. For general and internal sensibility, for the sense of temperature or of touch, a distinct pleasure presupposes some antecedent uneasiness or want. It is pleasant to eat or drink when we are hungry or thirsty, and to plunge into fresh water when the skin feels hot; but, if, when we eat or drink without previous hunger or thirst, we feel pleasure, it is because of some particular effect of the aliment on the specialized sense of taste. So, when the body is at the normal temperature, heat or cold will give it but a slight gratification. Contrast with antecedent pain seems in these cases to be necessary to present pleasure. On the other hand, only a slight degree of divergence on the side of pain, as in the case of a burn, a blow, or a colic, is enough to cause considerable suffering.

An opposite law rules in the higher senses, and particularly in those which have very specialized organs. In them pleasure arises immediately, and is capable of acquiring a notable degree of distinction at the very start from the point of indifference. This takes place in excitations of the sight, hearing, smell, and tase. In return, the higher senses are less subject to suffering than to simple annoyance. A discord, a piercing whistle, inharmonious colors, a dazzling light, and a disagreeable odor, do not provoke any pain of the hearing or vision comparable in intensity to that of a wound or a burn. These, we believe, are the real scientific reasons why the higher sensibility is free from necessity and "hunger," while the lower sensibility is enslaved to them.

If we compare the higher with the lower senses in respect to their activity, we shall find that a greater specialization corresponds with a lessened passivity, and a greater share of central activity and will-power. We have but little control over our internal organs; we can not, for example, put our stomach or our heart into the active attitude

of attention; but we can at will look, hear, smell, taste, or touch. Now, pleasure precisely corresponds with this higher activity.

Between the higher and the lower senses is a kind of intermediate class, the importance of which has not hitherto been sufficiently remarked—we mean muscular sensations, or sensations of resistance, which many philosophers regard as the base of all the other sensations. Now, in the movement of our muscles, in which our activity is continually applied to overcoming a resistance, and in which, therefore, we are perpetually active and passive, we see the pleasure of exercise and the pain of fatigue drawn clearly one upon the other, according to the exact relation that exists between our muscular force and the external resistance. This essential fact clears up the rest. It shows the intimate and primitive connection of pleasure with activity, and of pain with passivity. The possible independence in respect to necessity and pain manifested by the highest senses is still more remarkable in the intellectual, æsthetic, and moral pleasures which may even come without being sought. Of such is the pleasure of surprise. The first shooting-star that passes before the eyes of a child charms it without having been anticipated or desired. A discovery made without having been sought is a happy chance, a pure gain, an unexpected inheritance. For all these reasons we assume that there exist pleasures of surplus which attend an excess of activity or stimulation. In them the same cause excites activity and satisfies it, without the intercalation of any want, of any "mechanical or mental hunger" or unsatisfied desire. Kant's doctrine that one pleasure can not immediately succeed another without the interposition of a want or a pain is contradicted by the facts. If, while I am eating savory meats, I unexpectedly hear fine music and am surprised by the spectacle of graceful dances, I experience an increase in which pleasures are added to one another without my having to go through the gate of suffering. Furthermore, a progressive increase of pleasure would be impossible under Kant's theory, which supposes the necessity of successive breaks, or interrupting pains. Mr. Schneider believes that we are conscious of an agreeable feeling only when we perceive a change for the better, and of a disagreeable one when we perceive a change for the worse. His theory ends in the same vicious circle as Kant's: "We must suffer to be able to enjoy, and must enjoy to be able to suffer." How, then, do we get joy or suffering in the first place? The theories of Schopenhauer and Hartmann involve similar fallacies.

We have just shown that there exist direct pleasures, due to a surplus of activity without previous pain, the simple object of which is not the preservation of the organism in the struggle for life. We may go further, and ask if all pleasures, even those which appear to originate in a want, even those seemingly the grossest, are not of the same nature to one who looks to the bottom of the matter.

Does the complete satisfaction of a want, even of a physical one,

consist only in filling a pre-existing void, without anything more, and thus simply re-establishing an equilibrium? If it were so, the equilibrium would produce a mental condition of consciousness and feeling, or immobility, and there would be no evolution. What causes enjoyment in satisfying a want, such as the want of food or exercise, is that there is, relatively to the previous condition, a surplus, and hence a movement of progression in which is continuously produced an excess as compared with what we have just got, and we are enriched above our previous poverty. It is not, therefore, simple suppression of pain that constitutes sensual enjoyment, for that would be merely neutralization of the former condition by the after condition. Enjoyment is constituted by the suppression of pain *plus* an excess, which produces a progress, not a rest, of activity. The painful condition of hunger is composed of an infinite number of rudimentary pains. The pleasure which we feel in restoring our forces is a continual victory over these rudiments of pain, and produces something like the accelerated velocity of a moving body. But a continual victory is a continual surplus, and it is this surplus that makes the pleasure. Hence, not only does pleasure not require for its existence a previous want, but even when it succeeds a real want, as in many of the pleasures of the senses, it is nevertheless in itself independent of the want, or essentially positive. We can not, then, with Messrs. Leslie Stephen and Delbœuf, locate pleasure in the simple feeling of a normal equilibrium. Even in the act of eating, the pleasure felt incites the expenditure of energy, and the equilibrium is not reached till satiety causes the action to cease. The feeling of equilibrium only constitutes a general and fundamental comfort, very near to indifference. We can not be satisfied, either, with saying, with Mr. Spencer, that equilibrium is the accompaniment of normal action. To our mind pleasure, as a distinct emotion, appears precisely when the limit of normal action has been passed, for it supposes, at whatever point, a richness. We go, then, to the end of the way opened to us by the great philosophers, and define pleasure as the feeling of a surplus of activity. Its relation to pain only marks the beginnings, not the end, of evolution and selection; it is primary, but not definitive; it is accidental, but not essential.

We now turn to the final and fundamental question—Is pain the sole motive to activity, and consequently the real motive power of universal evolution? This discouraging doctrine may be found among other psychologists than Schopenhauer and the pessimists, and they have not always drawn from it the moral, metaphysical, and religious consequences that they might have drawn. According to Mr. Leslie Stephen, pleasure, being a condition of equilibrium, is for that reason a state of satisfaction in which there is a tendency to persist. Mr. Rolph ("Biologische Probleme") remarks that it is a state which we seek to prolong, and can therefore never be the cause of a change of condition. When it is objected to this, that man—when, for example,

he is under the influence of love—may seek a greater pleasure than the one that is present, and that the object of his action, in that case, consciously or unconsciously, is certainly pleasure, he replies, "Yes, but the actual motive is a feeling of non-satisfaction, which is the same as pain." This theory touches what are the most obscure as well as most important problems of psychology and morals. In our opinion, the doctrine of pain, as the motive of action, could be true only if all activity were solely applied to change toward another condition. Of this character are effort, want, and desire; hunger, thirst, hope, and anger. But is it certain that all activity consists thus exclusively in moving toward another condition, as a mobile material object moves toward another point in space? Is change, or unquiet, as the ancients said, the essence of action, or is it only the result of the limits of action, of its deficiency, or of the external resistance which it meets? Present enjoyment, such as the enjoyment of agreeable sounds or beautiful colors, so far as it is complete, and considered in itself, does not provoke the desire for anything else, is satisfied with itself. Does that mean that it is constantly passive and inert? From the circumstance that the action of the living being, being never solitary, is always exerted toward a point of application which itself reacts, it results that change is attached to activity, as a necessity of the resistances of the medium, if not of its essence. At the precise moment and in the measure that we are enjoying our active state, as in the contemplation of a scene of nature, we cease to desire change as Mr. Rolph and Leslie Stephen maintain; but no enjoyment and no action can continue long at the same level of intensity. The prolongation of the exercise and agreeable stimulation of the nerves tends to diminish the effect, according to the law of wear-and-tear. It is the feeling of this diminution, of this constant decline, in which pleasure betrays itself, which is the real excitant of the always reviving desire or hunger. But in this case the hunger is revived, because the former comfort, which existed independently of it, feels itself menaced, diminished, exhausted, and escaping as it were from itself. The pain is pleasure's cry of alarm, but pleasure does not essentially imply pain.

We see then, anew, that what is really primary is the action, the same in being and in comfort, from which arise, with external resistance, distinct pain, and, with victory over the resistance, distinct pleasure. Change, motion, and progress have their reason in the perfection of activity; but enjoyment is, as Descartes, Leibnitz, and Spinoza believed, the feeling of some actual perfection come to realization of some power.

In wholly absorbing activity into disquiet, want, or hunger, Mr. Rolph has only discerned half of the truth. He has not insisted enough on the counterpart of hunger and nutrition, which is the disengagement of force and movement. Like Darwin, whose doctrine he desired to perfect, he has considered principally the support and

development of the organs, not their exercise and the development of their functions. Hunger, regarded by him as the primary and universal feeling, has for its object the appropriation of matters coming from without. It is a force of concentration and absorption into itself. But, as we have seen, nutrition and the restoration of the organs, which simply store up the forces of tension by a kind of negative work, are not the real source of positive pleasures or of positive pains. It is in expending the energy of materials already appropriated that we feel pleasures and pains. In that way are brought about the development of the being and evolution toward new conditions of life: the living being acts upon the medium, and the medium is in turn modified by the increasing power of the being. There is, therefore, in animated nature a development from within to without, and not only a kind of envelopment and absorption from without by that which is within. The acquisition and restoration of the tissues suppose a certain activity already present, an anterior outbreak of life manifested by movement; and it is plausible to suppose beneath this vital movement, preceding the rudimentary pain caused by the exterior resistance, the rudiment of pleasure attached to the interior action.

The conclusions to which our study appears to have brought us are not less important for the theory of morals than for the theory of man and of the world. The first is, that natural selection, a wholly mechanical and exterior process, presupposes an internal principle of evolution, which principle is an activity capable of enjoying and suffering. A second conclusion is, that pleasure is immediately connected with action, and comfort with existence and the unfolding of life. Hence it follows that pain is not, as some of the pessimists believe, the principle of internal action and desire, but only that of the reaction on the external world.

Extending these results to the general theory of the world, we can infer from them that pain is not the sole motive of universal evolution. It is only at the origin of evolution that uneasiness, pain, or hunger, is the principal spur of which Nature avails herself. But in a higher degree in the scale of beings, pleasure, through the intervention of the thought that anticipates it, becomes the certain stimulus to activity. Hence, we have seen the higher senses effecting rapid condensations of an infinity of delicate and subtile pleasures, objects of luxury rather than of the necessities of material life; and evolution becoming a child of wealth, and not a child of poverty only. For this reason evolution does not seem to us to be solely "preservation of self," according to Darwin's term, or "maintenance of the normal equilibrium"; but it is, or may become, a progress. Pain, therefore, is not, as Schopenhauer and Von Hartmann maintain, the eternal and irremediable condition of beings, a kind of damnation, or a hell from which the world can not escape except by annihilation of itself.

Still other moral consequences, no less important, are brought out.

If hunger and inner nutrition are not the only law of being, if expenditure from self to without is also a fundamental and essential law, it results that egotism is not radical, and activity may really become loving. The being does not tend solely to bring everything toward itself, as if by a gravitation of which it is the only center; but it tends also to extend, to give, and to join itself. Utilitarianism, Darwinism, and Spinozism are passed by. Enjoyment, "pure and veritable," which is not merely a remedy for pain, thus becomes apparent as the overflowing activity, which feels itself at last free from obstacles, superior to what was strictly necessary for the satisfaction of want; it is no longer a simple balance, but a profit, and, as we think we have shown, a surplus. It is, therefore, in the domain of sense, something analogous to what in art causes pleasure by excellence, and realizes the supreme charm—grace. Grace is produced by a superabundance, resulting in enfranchisement from the rude struggle for existence, freedom and ease of motion, facile play of thought, expansion of the heart, and generosity of the will. True pleasure is the grace of life.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

SKETCH OF FREDERICK WARD PUTNAM.

By CHARLES C. ABBOTT, M. D.

OF the long series of living American scientists, probably no one is more generally and favorably known than FREDERICK WARD PUTNAM, Curator of the Peabody Museum of American Archæology and Ethnology, at Cambridge, Massachusetts, and Permanent Secretary of the American Association for the Advancement of Science.

Brief reference to Mr. Putnam's ancestry will prove of interest. He is a lineal descendant of John Putnam, who came from England, *circa* 1634, and whose family became very prominent in Salem, Massachusetts, particularly during the witchcraft delusion. A glance at the Putnam genealogy shows how large a proportion of the prominent people of that historic town, Salem, are included among his ancestors—Fiskes, Higginsons, Palfreys, Hathornes, and others. The same is true of his mother's family, the Appletons. As was the case with the Putnam family, the great majority were graduates of Harvard College, one of them, the Rev. John Rogers, being president of that institution.

Mr. Putnam was born at Salem, April 16, 1839, being the youngest of the three sons of Eben and Elizabeth Appleton Putnam. In very early life he evinced a fondness for natural history, which his parents wisely encouraged, and he was fortunate also in living in a town where was maintained a most excellent zoölogical museum.

Putnam's active scientific career dates from his election to mem-

bership of the Essex Institute, in 1855, he being then in his sixteenth year. In 1856 he was made curator of ornithology and cabinet-keeper. In the thirty years that have since elapsed he has taken an active part in the Institute, holding many important offices, and since 1871 has been its vice-president. It was in 1856, also, that he was elected a member of the Boston Society of Natural History, and here, too, his ability as a naturalist was promptly recognized, as shown by his being placed on many important committees, made a member of its Council, and in 1880 vice-president, a position which he still holds.

In February, 1856, a most important step was taken. Putnam entered the Lawrence Scientific School, and became a special student under Professor Agassiz. In a few months, Professor Agassiz made him an assistant at the Museum of Comparative Zoölogy, in special charge of the collection of fishes. In this capacity he remained until 1864, when he married and removed to Salem, to take charge of the Museum of the Essex Institute.

In August, 1856, Putnam joined the American Association for the Advancement of Science. In 1869, during Professor Lovering's absence in Europe, he acted for him, in the office of permanent secretary, and during this time was also local secretary of the Salem meeting. In 1873, on the resignation of Professor Lovering, he was elected permanent secretary, and has been re-elected three times, and is now serving his fourth term of five years, being, under the old and new constitutions, a continuous tenure of thirteen years. When elected to this responsible office, in 1873, the Association barely numbered five hundred members, and now has a membership-list of over two thousand names. It is unquestionable that this increase is largely due to Professor Putnam's executive ability and thorough realization of what such an association needs to make it a success.

In 1867 the trustees of the fund given by the late George Peabody for the promotion of science and useful knowledge in Essex County, Massachusetts, appointed Putnam Superintendent of the Museum of the East India Marine Society and the scientific collections of the Essex Institute, which the trustees had received as a permanent deposit, with authority to reorganize and arrange them in the East India Marine Hall. On the incorporation of the trustees of this fund, given by the great philanthropist, under the name of the Peabody Academy of Science, Putnam was appointed Director of the Museum, and held the office until he resigned in 1876, when he removed to Cambridge.

In 1868 the degree of A. M. was conferred upon Putnam, by Williams College, where he had lectured on zoölogy and aided in the scientific arrangement of the natural history collections.

In 1874 Putnam was an instructor at the School of Natural History on Penikese Island, taking charge of the school at the opening of its summer term, during the illness of Mr. Alexander Agassiz.

In this year, also, he was appointed an assistant on the Geological Survey of Kentucky, and passed several months in cave explorations. It was at this time that Salt and Saunders Caves were thoroughly explored and so much of archæological importance was discovered. A report of these "finds" was published in the "Proceedings of the Boston Society of Natural History." Important zoölogical results were also obtained from the same and other caves, and accounts thereof published in various journals of learned societies, and subsequently issued as a separate volume, under the joint authorship of F. W. Putnam and A. S. Packard, Jr.

In September, 1874, on the death of Professor Jeffries Wyman, Putnam, at the request of Professor Asa Gray, took temporary charge of the collections of the Peabody Museum of American Archæology and Ethnology, in connection with Harvard University. At the annual meeting of the board of trustees, in January, 1875, Putnam was appointed Curator of the Museum. That such action should have been taken was most natural, as Professor Gray, in his single brief report as curator *pro tem.*, remarks: "As respects the care of the museum during the short period in which I have endeavored to act as temporary curator, while I have given to it such attention as I could, it was soon evident that the lack of time and of the requisite technical knowledge would prevent me from personally carrying on the work which had to be done. I therefore availed myself of the permission granted at a former meeting of the board, and engaged the valuable assistance of Mr. F. W. Putnam, of Salem, who is better acquainted than any one else with the museum, and with Dr. Wyman's method and arrangements, having been much associated with him both in exploration and publication." The above clearly shows that, of many who would have gladly undertaken the care of the museum, no one was so eminently fitted for the position.

In 1876 Putnam was also appointed an assistant in the Museum of Comparative Zoölogy, in charge of the collection of fishes, which duty was undertaken and continued until 1878, when domestic affliction necessitated his resignation.

In 1876 the Engineer Department of the United States Army appointed Putnam to take charge of and report upon the archæological collections made by the *attachés* of the Geological Survey, west of the 100th meridian, Lieutenant George M. Wheeler in charge. The report was finished in 1879, and constitutes Volume VII of the quarto publications of that survey. In the preparation of this volume, Putnam was assisted by several specialists; but his own hand is evident in the general editorial supervision of all parts, and the exhaustive article, covering fifty-five pages, on perforated stones, by Putnam exclusively, is one of the most complete and valuable contributions to prehistoric archæology by an American author.

As indicative of the value of his scientific labors, we find that, be-

tween the years 1858 and 1886, Putnam has been made a member or correspondent of twenty-seven learned societies in America, and of five in Europe. In April, 1885, he was elected a member of the National Academy of Sciences.

Although in recent years Putnam's attention has been given so largely to archæological investigations, his knowledge of general natural history has not been overlooked by those who best know him; and in 1882 Governor Long, of Massachusetts, appointed him a commissioner of inland fisheries for five years, and so far as practicable his attention is given to the onerous duties of this important office. By the special act of the Massachusetts Legislature, which took effect last month, he became Commissioner of Fish and Game.

Mr. Putnam's contributions to scientific literature have been many, and all are valuable. As early as 1855, communications with reference to the fishes of Essex County, Massachusetts, were published in the "Proceedings of the Essex Institute"; but his first paper of length and marked importance was the "Catalogue of the Birds of Essex County, Massachusetts," with notes; and reference to the ornithic fauna of the State at large. This paper, prepared while its author was yet in his teens, has stood the test of time, but two errors, and these unimportant, having since been detected.

This contribution to zoölogical literature was followed by thirty-seven papers on birds, reptiles, fishes, and insects, mostly native species.

In 1857, while attending a meeting of the American Association for the Advancement of Science, at Montreal, Putnam found, on the side of Mount Royal, near the site of the present reservoir, a quantity of clam-shells, fish-bones, burned earth, and pottery, and, during the following winter, called attention to them, at meetings of the Essex Institute, as evidence of the early occupation by man of that locality; that the spot was, in fact, a veritable kjökkenmödding, or, as we now call such accumulations, shell-heaps. This is among the first of such notices of ancient man in America.

In 1865, Putnam published a paper on "An Indian Grave and its Contents, on Winter Island, Salem, Massachusetts," and since then two hundred and twenty-nine papers have been given to the public.

His archæological activity may be said to date from the publication of his "Winter Island" paper, for, on looking over the long list of titles, it will be seen that, from this time, papers on early American man steadily increase in number, and the work of the zoölogist practically ceases. While archæologists have good cause to rejoice at this, it can not but be viewed with regret by the zoölogist, considering the character of the many papers on their favorite subjects.

Besides the immense amount of literary work thus briefly sketched, there is to be considered, also, Putnam's labors as an editor, for much

of the value of the "Proceedings of the Essex Institute," of the "Annual Reports of the Trustees of the Peabody Academy of Science," and of the annual volumes of the American Association for the Advancement of Science, Vols. XXII–XXXIV, is due to his careful editorial supervision. Putnam also was one of the original editors and published Vols. I–IX of the "American Naturalist."

While brief papers are continually appearing in various scientific serials, it is to the annual reports of the great museum, of which he is the head, that Putnam gives his principal attention. Already ten of these have been published under his direction, and others are in preparation. It is scarcely necessary to add that they contain an immense fund of invaluable archæological knowledge, and must, of necessity, be accessible to every one who would have a thorough knowledge, so far as it can be obtained as yet, of ancient man in America.

A perusal of these reports and a careful examination of the museum's collections at once show the eminent fitness of the man for the place, the method of conducting exploration and exhibiting the results thereof being that which a zoölogist adopts in treating of a purely zoölogical problem. It is not the design of the museum merely to group a vast amount of material together, in series of like objects, to show how varied is man's handiwork, but to let associated objects, as they occur, tell the story of the people who used them. This was the view taken by Professor Wyman in collecting the remains of ancient man from the Florida shell-heaps—he would have removed a shell-heap, bodily, to the museum, had it been practicable—and in this spirit, with by no means sufficient funds to carry on the work, Putnam has continued to labor, and succeeded in gathering a quarter of a million objects from every nook and corner of America.

Recently, the trustees of the Peabody Museum, in carrying out the objects of Mr. Peabody's trust—one of which was the establishment of a *professorship* of American archæology and ethnology—unanimously nominated Putnam for the position, and the corporation of Harvard College established the professorship.

The mantle of the late lamented Jeffries Wyman could have fallen on no worthier, abler shoulders than those of Frederick Ward Putnam.

EDITOR'S TABLE.

MORAL TEACHING IN THE PUBLIC SCHOOLS.

THE reason most frequently given for the introduction of more or less of theological doctrine into public school-teaching is that, without this, there can be no effective teaching of morality. The Roman Catholic Church has always urged this point very strongly; and other communions, if less definite in their claims, have in general shown a disposition to give the teaching of morals in the public schools a distinctly theological basis. The question should, therefore, be fairly met, whether morals can be taught apart from theology. If they can not, then there is only one thing for state-directed schools to do, and that is, to leave the whole subject alone; seeing that the teaching of a privileged and undemonstrable theology in such establishments is something the people as a whole will never consent to—something, indeed, entirely inconsistent with the most elementary notions of intellectual freedom.

By morals we understand the science or art of human conduct—the science, when studied theoretically; the art, when practically applied. We believe that the end of conduct is the promotion of happiness in the widest sense. Happiness is the end that every individual instinctively seeks; and happiness is the only end that the philosopher can discover, toward which conduct in general can be directed. Happiness, again, if a definition of it must be had, can only be understood as fullness and harmony of life; and the things, therefore, that tend to render life full and harmonious are the things that tend to happiness, and the things consequently that morality, as a science, should teach. But life is essentially a thing of relations, and of ever-multiplying relations as it grows in complexity. No human being can be understood apart from his relations to the social organism to which he belongs. As well, to use Mr. Spencer's illustration, try to understand a human arm severed from the body and without reference to, or knowledge of, the body as a whole. The harmony of individual life is consequently, in the main, a matter of adjustment to its social environment. Only through society does the individual gain a true knowledge of, or empire over, himself. Only through society does he discover his true destination in the performance of social (including domestic) duties and the enjoyment of social privileges. Only through society are his thoughts so far widened as to enable him to take a rational view of the universe, unobscured by personal illusions and undisturbed by superstition. The action of mind upon mind and the shock of opinion upon opinion are the guarantees at once of our intellectual liberty and of our mental sanity.

Now, we wholly fail to see why morality as the science of human duties, themselves considered as the foundation, the essential condition (demonstrably so) of human happiness, could not be taught very efficiently and satisfactorily in our public schools, without any reference to supramundane facts or theories. What we all have to do is to adapt ourselves to the conditions of life here; and some respectable theologians are to be found who hold that, if we succeed in doing that, we shall occupy a very good position for entering on any future life that may await us. Be that as it may, the business of adapting ourselves to our earthly environment is one that depends on a knowledge of mundane truths. Let our school-

teachers be at full liberty to expound the laws of human life and well-being to their pupils. Let them show them what they are and what they are adapted for, and how each kind and grade of happiness — physical, intellectual, moral, personal, domestic, social—attainable by human beings, depends on the wise and patient exercise of specific faculties and powers, on the steady pursuit of specific courses of action. Let him appeal less than has hitherto been done to the coarse and often hurtful stimulus of individual ambition, and more to the sense of comradeship and mutual good-will which is never wholly lacking in children. Let him exhibit civilization, as we now enjoy it, as the joint product of unnumbered minds and hands co-operating, often unconsciously, toward a common end; and let him point out that greater triumphs still are to be wrought in the future when the thought of the common good shall be present to every mind, and more or less sweeten every day of toil. The trouble with multitudes of men and women is that their true self-respect has never been properly aroused. Dreams of ambition may have been presented to their minds, but they have not been sedulously taught to consider themselves as capable of *good* things. They have heard in all probability that they have souls to be saved (or the reverse), but it has not been sufficiently impressed on them that they have characters to be refined, that they have the germs of a hundred good qualities which a little generous nurture would quicken into vigorous and beautiful life. From this point of view the old Socratic maxim, "Know thyself," acquires a new and powerful significance. To know one's self is to know one's own best capacities, and to know these is to desire to exercise them. To know one's self is to know one's weaknesses, and to know these is to be more or less on one's guard against them. In one aspect, therefore, the teaching of morals is simply the unfolding of the actual facts of human life. When the facts are once exhibited in their proper order and relation, the inferences to be drawn from them hardly require pointing out.

Far, therefore, from the teaching of morals in this sense being unsuited to the public schools, we conceive that it is precisely this that they should most earnestly concern themselves with. The system of state education is upheld on the ground that the stability of the state depends on the character of its citizens, and that this in turn depends on education. We do not now discuss that theory; we only say that a prime inference to be drawn from it is that whatever bears directly on character and conduct should take precedence, in state education, of what only bears indirectly thereon. And we hold not only that morals *can* be taught apart from theology, but that the less moral teaching is complicated with theology, provided only it is delivered with conviction, the better effects it will produce. We want to *know* the reactions that different courses of conduct produce in this world, not to *speculate* as to the reactions they may produce in a world of wholly different constitution. In all probability it may be difficult for a long time to come to obtain a generation of teachers capable of expounding a scientific morality with intelligence, conviction, and enthusiasm; but none the less is it clear that the only morality that can gain a permanent footing in the public schools is one capable of demonstration, one founded on the laws of life.

PSYCHOLOGY AS A SCIENCE.

In looking over the various departments of special scientific study mapped out in the organization of the American Association for the Advancement of Science, one searches in vain for any recognition of psychology. In the various sections provided for by the Constitu-

tion, the nearest approach to the psychological domain is found in biology and anthropology. We suspect that no student of mind would be content to allow his chosen science to be treated as an appendage to either of these sections, and yet it appears that he must find its place in one of them, if at all.

It can hardly be that this omission occurs because there are so few who are engaged in psychological study. The editor of "Mind" asserts that, of the contributions submitted for publication in that journal, the American articles indicate in our country a very deep and widely diffused interest in that subject, and have specially attracted his attention both for their quantity and for their excellence. American psychological students have recently demonstrated the existence of the temperature-sense as an independent sensibility. Every college has its department of mental science, and there are many well-known workers in this field. Even if such were not the case, still it may reasonably be supposed that one of the objects of the Association is to encourage labor in neglected branches of science by calling attention to them.

The probabilities are, that the old prejudice against "metaphysics" has survived and causes a reluctance to concede any scientific value to psychology. If this be so, it is certain that the feeling in question ought to be abated by a more just estimate. Time was, of course, when psychology meant speculation; but that time has passed away. Psychology to-day has just as definite a scientific character as has biology. Its study is pursued by strictly scientific methods, and by scientific tests its results are measured. True, indeed, this can not be said of all study that calls itself psychological. But then we have plenty of people terming themselves biologists whose methods and purposes are absolutely empirical. Yet there is a science of biology, and in as high a degree there is also a science of psychology, notwithstanding that there are sometimes empirics concerned in both. The latter has its distinct province, its subdivisions into various important departments with specialists in each; and the substantial additions it is constantly making to human knowledge are abundant enough and of sufficient consequence to entitle it, upon the most modest claims, to an honorable position in the circle of the sciences.

We think the American Association at its coming meeting would act wisely in creating a Psychological Section. Even if there be danger that psychology will sometimes run mad from the poison of metaphysical virus, it is well to reflect upon the truth in John Stuart Mill's remark to the effect that without philosophy we can never be really sure that we know anything.

LITERARY NOTICES.

The Elements of Economics. By H. D. Macleod. Vol II, Part I. New York: D. Appleton & Co. 1886. Pp. 376. Price, $1.75.

This is a work that departs widely from current economic doctrine. It is an attempt to reconstitute the science solely upon the basis of the law of supply and demand; and, while this may not at first sight seem a very novel proceeding, the results arrived at certainly differ greatly from those commonly taught. The main thesis to the support of which the author brings much ingenuity of argument is that debt or credit is wealth—not in the sense of being a representative of existing wealth, but a distinct addition thereto, and he holds that the too narrow conception of wealth heretofore held by economists has incapacitated them for dealing with the complicated phenomena of modern credit in any satisfactory way. The conclusion that debt or credit is wealth is a direct consequence of his definition of wealth, which he maintains is anything which is exchangeable whose value can be measured in money.

All property consists of rights, whether to material things, one's own labor, or to a participation in the future profits of any

undertaking. A debt as an exchangeable commodity is simply a "right of action." It lies wholly in the future; but it has a present value; and when put in the form of a negotiable instrument can be bought and sold equally with any material commodity. As instruments of credit can be multiplied indefinitely beyond existing material property, they form a distinct addition to existing wealth.

All wealth being produced in order to be exchanged, the problem of economics, according to our author, is to determine the conditions in conformity with which exchanges take place—that is the law of value. In arriving at this he sweeps aside the doctrine that value is due to labor, or is determined by the cost of production. Cost of production is simply the lower limit below which the value of anything can not stay for any considerable time and the thing continue to be produced. The labor embodied in anything bears no definite relation to its value. Many valuable things have no labor whatever associated with them. The sole cause of value, the author contends, is demand. If anything will exchange for something else, it has value; if it can not be exchanged, it has no value. Value, therefore, is not something which resides in a thing, but is given to it by the consumer. The same thing may consequently have very different values in different times and places. Value always being a ratio—a relation between two things—it follows that intrinsic value is a contradiction. The search for an invariable standard of value which is based upon the conception of intrinsic value is a wholly futile proceeding. Money may, indeed, be a measure of value—that is, the medium in terms of which all other values are reckoned—and this is quite sufficient. An invariable standard of value is not only unobtainable, but would be wholly useless if it were obtainable.

With these two postulates, that anything is wealth which can be bought and sold, and that the value of anything depends solely upon the relation between supply and demand, the author undertakes a consideration of the various problems of the science. We can not here undertake to follow him in his exposition, but will simply indicate the scope of his inquiry. The first volume, which was published some five years ago, is mainly devoted to establishing his propositions with regard to wealth and value. As if afraid to get too far away from the economists of acknowledged position, he fortifies himself at every step by numerous quotations from their works, showing that they have at one time or another admitted the validity of his own position. In the present volume, which closes his discussion of "Pure Economics," he considers the relation of labor to value, and the conditions affecting the wages of labor. He scouts the wage-fund theory, and contends, in agreement with various other economical writers, that the wages of labor come out of production; but he has nothing hopeful to offer to wage-workers, simply contenting himself with admonishing them to keep their numbers down.

Upon the subject of the rent of land, the author is quite at variance with the most authoritative economic teaching. He has small respect for the Ricardian theory, and maintains that Ricardo has uniformly inverted cause and effect. He does not see that land offers any special feature that takes it out of the realm of other economic quantities. The owner of a piece of land has the right to the successive crops forever, and its purchase-price is simply the summation of the present value of the successive future returns. The rent of land is simply the interest on the purchase-price.

Rights, or incorporeal wealth, the foreign exchanges, the currency, Law's theory of paper money, and a consideration of the legislation affecting the Bank of England, make up the remainder of the volume.

Proceedings of the Colorado Scientific Society. Vol. II. Part I. 1885. Denver, Colorado. Pp. 36. Price, 50 cents.

The most important paper in the report is the address of the retiring president, Richard Pearce, on the growth and work of the society, particularly as they are related to the interests of Colorado. It claims that the science of mineralogy has been especially benefited by the society's labors, through which a great many additions have been made to the list of strictly Western minerals. The most important achievement is the discovery of three distinct new minerals.

Psychology: The Cognitive Powers. By James McCosh, D. D., LL. D., Litt. D. New York: Charles Scribner's Sons. 1886. Pp. 245. Price, $1.50.

The author says in his preface: "For the last thirty-four years I have been teaching psychology. . . . From year to year I have been improving my course, and I claim to have advanced with the times." No one acquainted with Dr. McCosh's earlier treatises would deny upon examining this one that he has "advanced." The trouble is, he has not advanced fast enough nor far enough—"the times" have distanced him in the race; and, after we have given all due credit, we have to confess to ourselves that this latest work leaves us with the consciousness of a good deal to be desired. We suppose the author would maintain that his account of the cognitive powers is scientific. But at the very outset a suspicion is cast upon its scientific character by the opening sentence: "Psychology is the science of the soul. . . . By *soul* is meant that self of which every one is conscious." Now, we fear Dr. McCosh's Scotch fondness for theological battles has interfered in this case with that simplicity of truth which the faithful expositor of science ought to exhibit in his statements. The implications of the word *soul* extend much further than is indicated. Dr. Reid expressed them when he said, "It is a primitive belief that the thinking principle is something different from the bodily organism, and, when we wish to signalize its peculiar nature and destiny, we call it *soul* or *spirit*." In a word, *soul* has reference distinctively to mind as immortal or as capable of existing independently of the present bodily organism. This meaning is not openly declared by Dr. McCosh, but by the use of the term an argument is quietly instilled into the mind of the reader. President Porter, who also calls psychology the "science of the soul," is much more frank in his exposition. But, certainly, inasmuch as the immortality of the soul is something which we all hope psychology will demonstrate as a result of the examination of mental processes and powers, would it not be more satisfactory to every one and add to the value of our researches if we did not start out with assuming the point to be proved? This same disposition to study mind for the purpose of substantiating some theory crops out all too noticeably throughout the whole work. To refer again to the preface, we are informed that idealism and agnosticism are to be exploded, and, as we go on, the claws of polemical metaphysics protrude far too often for the scientific value of the book. The writer is fond of "laying down" positions which "deliver us" from great philosophical errors of the day. No doubt they do, but the warrant for laying them down is unfortunately not always so plain as the eagerness to establish them.

This is a very serious defect. Besides, although we find much to approve in particular statements, the latest, the clearest, the best results of psychological study are not brought out nor recognized as they should be. The same cloudiness and contradiction which perplex the student in the "Intuitions of the Mind" annoy us here. The classification of mental powers and their modes of exercise is cumbrous and antiquated. It is not so good as that of Sir William Hamilton, and is inferior to that of President Porter. We have, for example, no less than "six different capacities" of the representative powers, among which is placed association. But association is as much concerned with presentative knowledge as it is with representative; and even the old divisions of reproductive and productive imagination or memory and imagination would be quite sufficient to cover all not included under association. Moreover, it is very confusing to find afterward as distinct powers the comparative, including the apprehension of relations and discursive operations, as if the associative and representative powers were not adequate to explain all these mental acts. Moreover, under the "relations" classified, we notice identity and difference, and then resemblance. Obviously, identity is only complete agreement, and resemblance less complete; while it may be said of the whole catalogue of relations mentioned, that it would certainly be greatly simplified by almost every authority in psychological and logical science.

The treatment of the discursive operations is exceedingly meager, but doubtless the author thinks this should be left for logic. The exposition of sense-perception is

in the main good. Here the work is least anachronistic. We are glad to see that Dr. McCosh enunciates clearly that sensation and perception go together, there being no sensation without perception. We wish he had also made evident the fact that there can be no perception without representation. There is some useful information in the finer print notes, and the student ought not to overlook it. This last is true of other parts of the book as well.

However much fault we may be disposed to find with this treatise, considered as a scientific account of the cognitive powers, we think no one can deny that it contains much valuable moral didactic. The dangers of novel-reading are vividly portrayed; "some even of our Sabbath-school stories" tend "to dissipate and weaken the mind." Attention is called to the fact that "those who would allure the thoughtless know well how to set off sin and folly by theatrical accompaniments, by the setting of cut flowers which look pretty by night, but which are faded on the morrow"; and warnings are uttered in great profusion against evil habits of all sorts. This is, of course, very excellent. It makes the book a safe one to put in the hands of youth. It also adds to its merit that we can unreservedly say, as the critic whom Leslie Stephen quotes in the preface to his "Science of Ethics" remarked of Dr. Watts's sermons, that there is nothing in President McCosh's work "calculated to call a blush to the cheek of modesty."

Manual Training. By Charles H. Ham. New York: Harper & Brothers. Pp. 403, with Illustrations.

Mr. Ham is evidently an enthusiastic believer in the full efficacy and competency of manual training—habitude in the use of tools and the execution of designs—to work out the solution of social and industrial problems. He regards tools as the great civilizing agency of the world; believes that "it is through the arts alone that all branches of learning find expression, and touch human life"; and accepts as the true definition of education "the development of all the powers of man to the culminating point of action; and this power in the concrete—the power to do some useful thing for man—this must be the last analysis of educational truth." A study of the methods of the manual training department of Washington University at St. Louis brought him to the conclusion that the philosopher's stone in education had been discovered there. He wrote constantly on the subject for three years, and in the mean time the Chicago Manual Training-School was established. The account of this institution and its operations forms the basis of this work, which includes also a kind of general survey of the whole theory and history of education from the point of view which the author has described himself as occupying. In the book are included descriptions of the various laboratory class processes of the Chicago school during the course of three years; arguments to prove that tool practice is highly promotive of intellectual growth, and in a still higher degree of the upbuilding of character; a sketch of the historical period, in order to show that the decay of civilization and the destruction of social organisms have resulted directly from defects in methods of education; and a brief sketch of the history of manual training as an educational force. The disposition to exalt the "new education," which is one of the most striking characteristics of this book, is deserving of all honor. That education, most men will admit, has been too much neglected in our times, and is unappreciated and discouraged to-day by the very men who ought to be most interested in upholding it—the artisans themselves, as represented by their trades-unions. It is well for it to have an advocate whose heart is full of it. Another disposition, and a still more striking characteristic of the book, is not so commendable: we mean the disposition to decry the old education and its fruits. To say that the value to man of the services of such a statesman as Mr. Gladstone—who is undoubtedly one of the best fruits of the old system of education—is relatively unimportant, while that of Mr. Bessemer's services is "enormous, incalculable," is rank nonsense; and this we may say without underrating the benefit mankind have derived from Mr. Bessemer's invention. The old education, which has given us Mr. Gladstone and the statesmen, and numerous artists and illustrious invent-

ors, and made Mr. Bessemer possible, has contributed a large part toward making the world what it is. That it is not perfect, and has from time to time to be supplemented to meet the constantly developing wants of society, does not detract from its real value, or from the fact that whatever is brought in in addition to it is closely connected with it, and largely dependent upon it for the power to perfect itself. It was supplemented in the middle ages by something very like the manual training-schools, in the shape of the guilds, and the systems of apprenticeship and journeymen; and it is the workmen, who have deliberately cast these systems away, and are decrying all distinctions founded on excellence, and not the advocates of the old education, that have made the new training-schools necessary.

Contributions to the Tertiary Geology and Paleontology of the United States. By Angelo Heilprin, Professor of Invertebrate Paleontology at the Academy of Natural Sciences of Philadelphia. Philadelphia: Published by the Author. 1884. Pp. 117.

Professor Heilprin has, in the present volume, made a valuable addition to the literature on this subject.

Besides offering a general systematic review and analysis of the formation taken as a whole, a concise statement is given of the geology of the tertiary period in all of those States of the Atlantic and Gulf border where the formation has been determined; each of these States is separately considered.

The second division of the book treats of the relative ages and classification of the post-eocene tertiary deposits of the Atlantic slope; and contains carefully prepared faunal lists of Maryland, Virginia, and North and South Carolina.

The other divisions of the volume relate respectively to the stratigraphical evidence afforded by the tertiary fossils of the peninsula of Maryland; to the occurrence of nummulitic deposits in Florida, and the association of nummulites with a fresh-water fauna; a comparison of the tertiary mollusca of the Southeastern United States and Western Europe in relation to the determination of identical forms; and to the age of the Tejon rocks of California, and the occurrence of ammonitic remains in tertiary deposits. A map accompanies the volume.

The whole work bears the mark of careful study and research, and will undoubtedly greatly assist the labor of future workers in this field.

Annual Address. By C. V. Riley, as President of the Entomological Society of Washington for 1884. Pp. 10.

The society had just closed its first year when this address was delivered (March 18, 1885). The address notices some of the more striking entomological events of the year, and brings forward some general observations that are suggestive. With reference to the Entomological Division of the Agricultural Department, of which Dr. Riley is the head, no one more fully than himself appreciates how far it falls short of his own ideal and of the necessities of the country, or "how difficult it is to build up to that ideal under the unfortunate political unscientific atmosphere that pervades the department. . . . It was to get away from official surroundings, away from the work of the United States entomologist, that the members of the division decided to join in the organization of this society. It was still more to get acquainted with those of kindred tastes outside the department, in Baltimore and elsewhere, as well as in Washington, and to cultivate social intercourse and interchange of views and experience." The various branches of the science are well represented in the society and in the various collections in Washington.

The Climatic Treatment of Disease: Western North Carolina as a Health Resort. By Henry O. Marcy. Pp. 24.

The former subject mentioned in the title is considered in the first fourteen pages of this pamphlet. Concerning the second subject, we have a description of the triangular region between the Blue Ridge and the Smoky Mountains of Northern North Carolina, where, within an area of fifty miles, there are twenty peaks over six thousand feet high; nine tenths of the entire district is an unbroken, primeval forest of the largest growth, chiefly of decidu-

ous trees; and not a lake or a swamp is to be found in the entire region. The water is pure and abundant, and sulphur and iron springs are not rare. "One great benefit to invalids of all classes lies in the purity of the air, which the extraordinary forest-growth does much to render equable in temperature and moisture. Dust is unknown. The electrical phenomena of the summer storms are exceptional. . . . Notwithstanding the utter disregard of the laws of health by the inhabitants, they are a long-lived race of people."

Kant's Ethics: A Critical Exposition. By Noah Porter. Chicago: S. C. Griggs & Co. Pp. 249. Price, $1.25.

This volume is the fifth of Griggs's series of Philosophical Classics. President Porter enforces the description implied in the title that his treatise is both expository and critical. It proposes first to interpret and then to criticise the principal features of Kant's ethical system, and the one in order to effect the other. In performing his work, the author has thought it best to state the theory very largely in Kant's own language, with such comments as might be required to make it intelligible; and he has done this, both in order that he might be entirely just to Kant himself, and that he might aid the unpracticed student in the task of interpreting the German philosopher. Besides a brief general introduction, President Porter gives a summary or condensed review of the distinctive positions taken by Kant upon the most important topics as compared with those of other writers, and strictures upon Kant by a few German critics.

The Economical Fact-Book and Free-Trader's Guide. Edited by R. R. Bowker. New York: The New York Free-Trade Club. Pp. 151.

This volume is in the main a statement of facts, given in their most concise shape, without varnish, with some statements of opinion in which both sides are represented for guidance in making up the mind on the tariff issue. It is prepared for the furtherance of free-trade principles, which the editor assumes in the introduction, are supported by the facts of history and of present experience, as well as by the principles of economics. In it are a short history of the tariff, quotations from American leaders and party utterances on revenue reform, "Protectionist Points and Free-Trade Facts," and valuable tables. Free trade is admitted to have several shades of meaning. The free-trade cause is said to include the great body of men who oppose the principle of trade-restriction called protection, and whose common aim is to get this "mischievous element" out of the tariff and confine taxes to the support of the Government. This implies a "tariff for revenue only. . . . The immediate steps to this end are the freeing of crude materials from duty at the bottom, and the reduction of excessive duties at the top. All shades of revenue reformers unite in these steps, and are willing that their success should be the test of further advances in freeing trade."

Municipal Administration. By Robert Mathews. Rochester, N. Y. Pp. 16.

This pamphlet embodies the substance of an address delivered before the Fortnightly Club of Rochester. After reviewing the whole subject, the author reaches the conclusions that the misgovernment of cities is due to the imperfections of human nature, imperfections of our election machinery, and mistaken ideas about the proper functions of city government. The reforms needed are proportional representation, business administration, and that elevation of humanity which is both a cause and a consequence of good government.

Bulletin of the United States Geological Survey. Nos. 15 to 26. Washington: Government Printing-Office.

No. 15 is "On the Mesozoic and Cenozoic Fauna of California," by Dr. C. A. White. No. 16 is "On the Higher Devonian Fauna of Ontario County, New York," by J. M. Clarke. No. 17 is "On the Development of Crystallization in the Igneous Rocks of Washoe, Nevada," etc., by Arnold Hague and J. P. Iddings. No. 18 is "On Marine Eocene, Fresh-Water Miocene, and other Fossil Mollusca of Western North America," by Dr. C. A. White. No. 19 is "Notes on the Stratigraphy of California," by George F. Becker. No. 20 is "Contribu-

tions to the Mineralogy of the Rocky Mountains," by Whitman Cross and W. F. Hillebrand. No. 21 is "The Lignites of the Grand Sioux Reservation," and a "Report on the Region between the Grand and Moreau Rivers, Dakota," by Bailey Willis. No. 22 is "On New Cretaceous Fossils from California," by Charles A. White. No. 23 is "Observations on the Junction between the Eastern Sandstone and the Keweenaw Series on Keweenaw Point," by E. D. Irving and T. C. Chamberlin. These constitute Volume III of the "Bulletin," a volume of 498 pages, with many plates, and are sold separately at five cents each, except No. 20, the price of which is ten cents, and No. 23, fifteen cents. No. 24, which will be the beginning of Volume IV, is a "List of Marine Mollusca, comprising the Quaternary Fossils and Recent Forms from American Localities between Cape Hatteras and Cape Roque, including the Bermudas," by W. H. Dall, twenty-five cents. No. 25 is "On the Present Technical Condition of the Steel Industry in the United States," by Phineas Barnes, ten cents. No. 26 is "On Copper-Smelting," by H. M. Howe, ten cents.

An Introduction to the Study of the Constitutional and Political History of the States. By Franklin Jameson. Pp. 29. A Puritan Colony in Maryland. By Daniel R. Randall. Pp. 47. Baltimore: N. Murray. Price, 50 cents each.

These essays are, respectively, Nos. 5 and 6 of the fourth series of the "Johns Hopkins University Studies in Historical and Political Science." Mr. Jameson's essay is an endeavor to illustrate the importance of the study of local political movements, from those of the town and township to those of the State, in their bearing on the constitutional development of State and national governments. In it, he notices the tendency, which is not a good one, to insert provisions respecting details, mere temporary elements, into constitutions, as tending to impair the reverence with which those charters ought to be regarded, to lower their authority, and to introduce into our governments a most undesirable instability. Mr. Randall's study relates to the history and influence of a colony of Puritans—whose first leader, the Rev. Alexander Whittaker, performed the baptismal and marriage ceremonies for Pocahontas—that was planted at Norfolk, Virginia, in 1611, and removed thence on account of persecution, and settled at the mouth of the Severn River, in Maryland, in 1649. It formed the nucleus of the democratic party in Maryland. A parallel is drawn between its history and that of Providence Plantations, in Rhode Island: "As Roger Williams was driven from the mother Commonwealth of Massachusetts for holding heretical doctrine, so Durand, the Puritan elder, was expelled from the mother colony in Virginia, to seek a new home for religious toleration. Both leaders came to lands unoccupied, save by Indians, and invited their brethren to follow. Both called the land to which they came through divine guidance, 'Providence.'"

Proceedings of the Davenport Academy of Sciences. W. H. Pratt, Recording Secretary. Vol. IV. 1882–1884. Davenport, Iowa. Pp. 358, with Six Plates. Price, paper, $4.

The present volume contains a brief synopsis of the proceedings of the Academy for the years 1882, 1883, and 1884, in which the memoirs, chiefly on subjects of botany, fossils, and archæology, hold the prominent place, with the contributions to the museum during 1879, 1880, and 1881. Among the memoirs are several of value to the flora of Iowa, and some of value to botany, including a few carefully prepared special papers. Concerning fossils, are some descriptions of new crinoids and blastoids. In archæology, Dr. W. J. Hoffman contributes "Remarks on Aboriginal Art in California and Queen Charlotte's Island"; Mr. William H. Holmes a monograph on "Ancient Pottery in the Mississippi Valley," the fruit of studies in the collections of the Academy's museum; and Mr. C. E. Harrison and Dr. C. H. Preston accounts of mound explorations. Mr. Putnam's paper on "Elephant Pipes and Inscribed Tablets," concerning which subjects Mr. Powell, of the United States Geological Survey, has controverted the views held and put forward by the Davenport investigators, is published as a supplement, to place on permanent record the position and arguments of the latter. The publication of Volume V of the

"Proceedings" has been begun, and four papers intended for it are in the hands of the printers. Notice is taken of the fact that the indebtedness on the building of the Academy has been paid, and the formation of a permanent endowment fund has been begun. Two chapters of the Agassiz Association of America for the study of natural history, and a "Humboldt Society," which seeks to unite philosophical speculations with scientific investigations, have been formed in Davenport, and hold their meetings in the rooms of the Academy. It is observed that the membership of these organizations is made up wholly of young men and women, largely students in the public schools of the city. These facts, and everything connected with this volume, speak well for the earnest interest that prevails at Davenport in the study of science.

On Small Differences of Sensation. By C. S. Peirce and J. Jastrow. Pp. 11.

A record of experiments to determine the point at which differences in the intensities of nerve excitations cease to be perceptible. Among the points brought out is the probability that we gather what is passing in one another's minds in large measure from sensations so faint that we are not fairly aware of having them, and can give no account of how we reach our conclusions about such matters. The insight of women as well as certain "telepathic" phenomena may be explained in this way.

A Treatise on the Diseases of the Nervous System. By William A. Hammond, M. D. Eighth edition; with Corrections and Additions. New York: D. Appleton & Co. Pp. 945. Price, $5.

It would be hardly possible to give a better evidence of the merit of this work than is afforded by the appearance of this, the eighth edition, testifying that during the fifteen years it has been before the public it has been tried and found not wanting. The first edition was published in 1871, as resting to a great extent on the author's own experience. Its declared purpose was to be a treatise which, without being superficial, should be concise and explicit, and, without claiming to be exhaustive, should be sufficiently complete for the instruction and guidance of those who might consult it. The sixth edition, in 1876, was entirely remodeled and greatly enlarged. The seventh edition received extensive additions, and was translated into Italian under the supervision of Professor Borrelli, of Naples. The opportunity given by the appearance of this eighth edition has been improved to revise the work thoroughly, make several changes, and add a section on "Certain Obscure Diseases of the Nervous System."

A Critical History of the Sabbath and the Sunday in the Christian Church. By A. H. Lewis, D. D. Alfred Centre, New York: The American Sabbath Tract Society. Pp. 583. Price, $1.25.

Dr. Lewis is a prominent minister of the Seventh-Day Baptist Church, which teaches, according to his own statement, "that the law of God as contained in the Decalogue is eternal and universal, both as to its letter and its spirit; therefore, the seventh day is the only Sabbath; that under the gospel it should be observed with Christian freedom and not Judaic strictness, but that the change which Christ taught was a change in the spirit and manner of the observance, and not in the day to be observed." The argument pursued in this work is exclusively historical, and is intended to show that no authority worthy of respect exists or ever existed for the change that has been made in the day to be observed—from the seventh day to the first. The evidence, which is intended to be full and continuous from the gospels down, is given in the exact words of the texts cited, and in all the words that bear on the subject, and not in paraphrases or abstracts, so that, if any mistake be made in its import, it shall not be the author's fault. In this way Dr. Lewis attempts to show that no change is authorized in the Gospels, or in the words of any of the apostles; that the change was not made or recognized in the first two centuries; that the first signs of it appear in the days of Constantine, when the seventh day was still observed as the Sabbath, and Sunday, being the day of the resurrection, was celebrated in addition, as a religious festival; that Sunday observance gradually grew at the expense of the seventh-day observance, particularly under the auspices of the Latin Church, and under the

impulse of a spirit of concession to paganism and worldliness; that the seventh-day Sabbath was preserved much longer in the Eastern churches; and that the present decay of Sunday is a logical outcome of the disregard of the sanctity of the original, divinely instituted, but never divinely changed Sabbath. Dr. Lewis believes that the general results of civil legislation respecting the Sabbath—like those of legislation on all religious questions—have been evil. "Take the question," he says, "out of politics, out of the realm of caucussing and plotting, and let the Church settle it as it would any other religious issue. For . . . if the day ought to be kept by divine authority, the civil law can not strengthen that authority, and by a false application it may weaken and destroy it; and if he who does not rest out of regard to the Lord, does not truly Sabbatize, his resting is only an empty form or a blasphemous pretense. Under the working of the civil law as the prominent element of authority, Sunday has tended and must tend to holidayism; and, with the masses, toward debauchery."

Medicine of the Future. By Austin Flint (Senior), M. D. New York: D. Appleton & Co. Pp. 37, with Portrait. Price, $1.

The manuscript of this paper, which was the address the author had intended to read, by special appointment, before the British Medical Association at its meeting in 1886, was found after Dr. Flint's death among his papers. Considering the progress which has been made in medicine during the past fifty years, the author anticipates as great, or greater, in store for the next half-century, and indicates the lines along which, in his view, it may be expected to be realized.

Life, its Nature, Origin, Development, and the Psychical related to the Physical. By Salem Wilder. Boston: Rockwell & Churchill. Pp. 350. Price, $1.50.

The author, whose business is an agency for the sale of goods, has been interested in questions indicated by the title of his book, and is not satisfied with the manner in which the physical philosophers of the day try to answer them. He has, therefore, inquired what science and scientific men teach respecting them, and presents the results of his investigation in the first part of the book. The second part is devoted mainly to ethical questions.

The Olden Time Series. No. 1, Curiosities of the Lottery, pp. 73; No. 2, Days of the Spinning-Wheel, pp. 99; No. 3, New England Sunday, pp. 65. Boston: Ticknor & Co. Price, 50 cents each.

A series of collections of advertisements, items, and articles illustrating, by contemporary representations, the usages and the ways of thought, as well as the economical condition, of the people of the "olden time" in New England, culled chiefly from old newspapers of Boston and Salem, Massachusetts, and arranged, with brief comments, by Henry M. Brooks. The volumes are adapted to gratify a growing taste, and are of a size convenient for the pocket. The matter of numbers one and three is all closely related to the subjects expressed in the titles; that of number two takes a range beyond the spinning-wheel, and is varied.

Lessons in Qualitative Chemical Analysis. By Dr. F. Beilstein. Arranged, on the Basis of the fifth German edition, by Charles O. Curtman, M. D. St. Louis, Mo.: Druggist Publishing Co. Pp. 200.

This is the second edition of a translation of Dr. Beilstein's "Anleitung," a popular German text-book on chemical analysis. Dr. Curtman has, however, considerably enlarged on the original, and made numerous additions. The opening chapter is given to chemical manipulations: it contains suggestions on the management of the blow-pipe, the handling of glass-tubing, the working with corks, etc. These directions are supplemented by a series of examples for practice in the qualitative analysis of inorganic substances. Directions for the systematic examination of substances containing one base and one acid come next in order, and these again are followed by instructions for a systematic course of qualitative analysis.

The remaining chapters are devoted to examples for practice on the analysis of organic substances, to volumetric analysis, to the examination of drinking-water, the analysis of urine, urinary sediments, and

calculi. A colored plate of flame and absorption spectra and a plate illustrating various urinary sediments, are added; moreover, some illustrations are given in the text.

This book is primarily intended to be used as a class-book in the laboratories of medical and pharmaceutical schools, but it is also well adapted for self-instruction in the principles of chemical analysis.

Watts's "Manual of Chemistry." (Based on Fownes's "Manual)." Vol. II. Organic Chemistry. Second edition. By Professor William A. Tilden. Philadelphia: P. Blakiston, Son & Co. 1886. Pp. 662.

The general favor which is accorded to Mr. Watts's editions of Fownes's "Manual of Chemistry," shows how well adapted is the work to meet the wants of teachers and students.

Professor Tilden, of Birmingham, the editor of this issue, has closely adhered to the plan of his predecessor, and has mainly endeavored to make the corrections and additions rendered necessary by the progress and development of the science. The nomenclature has been made as uniform as possible, and has been brought into accordance with the system adopted by the London Chemical Society.

The introduction treats of the synthesis of organic compounds from inorganic materials, of ultimate analysis, the classification of organic compounds, their physical properties, and the decompositions and transformations of these bodies.

The chief division of the carbon compounds is, of course, into the fatty and the aromatic groups, or, as they are styled, into methane-derivatives and benzene-derivatives.

In the subdivisions of these groups the organic compounds are classified according to their chemical structure and functions; the compounds in each group are arranged in homologous series, and the several groups are separately considered. While the editor has tried to avoid swelling the volume to too large a size, he has aimed to give in it an account of, or at least a reference to, all carbon compounds which can fairly be regarded as having any considerable theoretical interest or practical importance.

The State Control of Medical Education and Practice (in the negative). By Romaine J. Curtiss, M. D. Joliet, Illinois. Pp. 32.

Dr. Curtiss writes in the spirit of a man who considers himself engaged in a controversy. His situation, in fact, invites vigor on the part of a disputant who speaks from his side, for he is a physician in a State where State control is exercised quite fully. Along with many expressions which might be softened without diminishing their argumentative strength, we find points presented that apply with much force in favor of the negative side of the question; among them the one embodied in the opening paragraph: "The modern method of throwing physic to the dogs seems to be to put the matter of medical education and practice under the control of the State; which means, of course, nothing more or less than making medical education and practice a factor of State politics. This method assumes that politics is a better criterion of the standard of medical education than any educational test, or any life-test, and also assumes that colleges are not qualified, by reason of natural favoritism, to judge of the merit of their work." This description may not now apply, as a fact, in any State, but, the political factor once introduced, there is danger, as the political machines have been running, that the ultimate result may be fitted to it.

On the Development of Viviparous Osseous Fishes, and of the Atlantic Salmon. By John A. Ryder. Washington: Government Printing-Office. Pp. 36, with Seven Plates.

The former paper is intended to give a summary of our knowledge respecting the best known of the truly viviparous osseous fishes characterized by an intra-follicular or intra-ovarian development. The second paper is based on the investigation of recently hatched embryos of the landlocked salmon.

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Netto, Dr. Ladislao. Conférence faite au Muséum National. (Lecture at the National Museum, on Brazilian Archæology.) Pp. 28. Lettre à M. Er-

nest Renan à propos de l'Inscription Phénicienne Apocryphe. (Letter to M. Ernest Renan, respecting the Apocryphal Phœnician Inscription.) Pp. 39 Rio de Janeiro.

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State Board of Health of Illinois. Seventh Annual Report. Springfield, Ill. Pp. 613.

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Alabama Weather Service. June. 1886. Pp. 7. Special Paper of the same, on Preparation of the Soil. By Captain W. H. Gardner. Pp. 6. Auburn, Ala.

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Patton, A. A., New York. Responsibility of Vocal Teachers as Voice-Builders. Pp. 20.

Shufeldt, R. W. A Navajo Skull. Pp. 4, with Plates. Remarks of Professor Sir William Turner on this Paper. Pp. 2. Osteology of Conurus Carolinensis. Pp. 18, with Plates.

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Roby, Henry W., M. D. The Treatment of Disease from the Homœopathic Standpoint. Pp. 37.

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POPULAR MISCELLANY.

Advantages of the Lick Observatory.—Mr. David P. Todd, in a pamphlet descriptive of the Lick Observatory, Mount Hamilton, California, mentions as among the advantages of its peculiar situation that the steadiness of the atmosphere at that height permits the regular employment of telescopic eye-pieces which magnify two or three times as much as the instruments in ordinary use. "It is thus not unreasonable to expect that a few nights in the course of each observing year may be found when the maximum magnifying power—about thirty-five hundred diameters—may be advantageously employed on the great telescope. The theoretical distance of the moon would then become about sixty miles, but the corresponding ideal conditions of perfect vision can never be obtained." The observer might, however, expect to see the moon

much the same as he would without the telescope if it were only a hundred miles away. "The fact of mere elevation (less than a mile) above the sea-level," Mr. Todd observes, "will not, as is often supposed, greatly increase the apparent light of celestial objects, as the stars will appear to be only a small fraction of a magnitude brighter on the mountain than at the sea-level. But—what is incomparably more important—the gain in steadiness of the atmosphere has been much greater than any one expected at the onset, and will enable the astronomer not only to make good use of a multitude of clear nights which at less elevated stations are found to be of little value, but also to elevate the grade of all his work to the last degree of precision. Fewer observations will be required for the accurate determinations of the positions of stars. The elevation also makes effectively available a much larger region of sky than can be commanded at other stations in a like latitude, where observations at zenith distances much greater than seventy degrees are usually not worth the making."

Horse-Eating.—The origin of the use of horse-flesh as food is lost in the night of the past. The ancients held the meat in high esteem, and a number of modern peoples use it unhesitatingly. Several Latin and Greek authors mention it. Virgil, in the third book of the "Georgics," speaks of peoples who live on the milk, blood, and meat of their horses. Pliny and Martial refer to the same fact. Pliny says that the ancient Germans killed horses for food, and ate their raw flesh after they had made it tender by carrying it under their legs as they rode. Mixed with mare's milk and blood, this meat formed a royal dish; and the Sarmatian when pressed by hunger never hesitated to procure it for himself by cutting the veins of the animal on which he was riding. The ancient Persians held horse-meat in high esteem for their great feasts. Several Asiatic peoples offer it to guests as a mark of honor. The Tartars regard it as a most delicate meat, preferring the fat and viscera; and Tott, who was sent by the King of France on a mission to the Khan of Tartary, ate excellent smoked horse-sides at his Highness's table. The Yakut bride offers her spouse a cooked horse's head garnished with sauces from the same animal, and this dish constitutes the staple viand of the wedding-feast. The Arabs think as much of horse as of game, and the Chinese use it generally and daily. The South American Indians are passionately fond of horse-meat. The natives of Sumatra have a decided preference for it, particularly if the animal has been well fed on native grains. While horse-flesh was generally eaten among the Germans till they were converted to Christianity, or till the days of Charlemagne, it was regarded with aversion by the early Christians as a relic of idolatry. Gregory III, in the eighth century, advised St. Boniface, Archbishop of Mayence, to order the German clergy to preach against horse-eating as unclean and execrable. This prohibition being ineffective, Pope Zachary I launched a new anathema against the unfaithful "who eat the meat of the horse, hare, and other unclean animals." This crusade was potent over the defectively informed minds of the people of the middle ages, and they, believing the meat to be unwholesome and not fit to eat, abstained from it except in times of extreme scarcity. Nevertheless, it continued to be eaten in particular localities down to a very recent period. The present revival in the use of horse-flesh, concerning which the French papers have had much to say, is the result of a concerted movement among a number of prominent men, the principal object of which was to add to the food resources of the world.

Extremes of Weather in the Past.—Captain W. H. Gardner has examined, for the Alabama Weather Service, the records of the weather—such as exist—from 1701 to 1885, and concludes from them that spells of severe weather of all kinds—extreme heat and cold, violent storms, hurricanes and tornadoes, disastrous floods, and parching droughts—were no more rare in the last century and the earlier part of the present century than now. In 1701 there were recorded at Biloxi, Mississippi, a winter cold that instantly froze water poured into a tumbler, and an August heat that made labor impossible except for two hours in the morning and two in the evening. In the

winter of 1746 water was frozen solid in the houses at Charleston, South Carolina. In 1748 and 1768 the Mississippi River at New Orleans was frozen from thirty to forty feet from the shores. In 1823 skating was possible on all the standing water in and around Mobile. In 1827–'28 the ground in Alabama, Georgia, and South Carolina, was frozen hard from December till March. A flood in the lower Mississippi and a "fearful hurricane" on the Gulf coast were recorded in 1723; another destructive hurricane in 1732; and overflows of the lower Mississippi from January till June, 1735; after which came a long drought, and a lower river than had ever been known. In a hurricane at Dauphin Island, in September, 1740, a four-pounder cannon was moved by the wind to eighteen feet from where it had been lying. Other hurricanes of extreme fury were recorded in October, 1778; August, 1779; August, 1780; and August, 1781. In the last year the Mississippi at New Orleans, the Attakapas, and the Opelousas, were higher than ever before known. The Mississippi at St. Louis was equally high in the flood of 1785 and in July, 1884, and it reached its highest recorded flood in 1844. The flood of the Ohio River in 1832 was not exceeded till 1883. The year 1840 was one of almost continued drought in Alabama and Mississippi, and prayer-meetings were held in view of the apprehended famine. These are only a few of the instances of remarkable phenomena, comparable to those that now attract attention, of which mention is made in Captain Gardner's record.

Coal-Waste as a Manure.—Mr. J. A. Price, of Scranton, Pennsylvania, recommends the use of culm, or coal-waste, in agriculture, by reducing it to dust and applying it to land, to darken the color of the soil, produce porosity, and stimulate plant-life. His opinion that benefits will be derived from this application is confirmed by the experiments he has made. A dark color of the soil is usually associated with fertility, and with reason, for it promotes the absorption of heat and thus makes the soil warmer and prolongs the season of freedom from frost at both ends. Mr. Price's observations of the effect of colors on soils side by side, and otherwise precisely alike, showed that a vigorous existence was maintained on a soil darkened by waste-coal, greatly in excess of that of the adjoining strip which was left in its original condition. So in the quality of porosity, in a soil treated as the author recommends—a blue clay or hard pan taken from an excavation and fertilized with organic manures—it was found that greater porosity as well as improved color was given, and the two sections, treated and untreated, exhibited all the peculiar features of two different soils. The corn upon the culm charged section exhibited a vigor of growth of tap and stay roots and of stalk and ear that surprisingly surpassed that of the other section. This result has been maintained through several plantings; and similar effects were observed with Lima beans. Since coal contains nearly all of the substances requisite for the healthy growth of plants, it is reasonable to suppose that its application will have the effect, as it is gradually decomposed by chemical action, of a positive manure. This supposition has also been confirmed by the experiments. The fertilizing results of this kind begin to reveal themselves in the second year.

The Irrawaddy River.—One of the largest rivers in the world is the Irrawaddy, and it is surrounded with a great mystery as to where is its source. The sea-front of its delta extends over about one hundred and fifty miles, with nine or ten mouths distributed over the space. The average annual discharge is about 521,794,000,000 of cubic yards, very nearly four fifths of that of the Mississippi River. But, while the Mississippi discharges pretty evenly all the year round, the Irrawaddy sends down three fourths of its total in the three months, July, August, and September, or in other words its monthly flood average is more than twice as great as that of the Mississippi. The extreme flood discharge of the Irrawaddy for one day in 1817 was at the rate of nearly 2,000,000 cubic feet per second, while the lowest known discharge occurred in the same year, and may be given in round numbers as 50,000 cubic feet per second, or one fortieth of the flood discharge. The highest flood discharge in one day is fifty per cent

greater than that of the Mississippi, and double that of any river in Europe. The magnitude of the Irrawaddy in its mid-portion causes astonishment to every visitor whose ideas are formed from Western maps. Captain Hanney says, on this subject: "To this point no diminution in the volume of the Irrawaddy was perceptible, from which we may infer that all the principal feeder affluents which pour tributary streams into the Irrawaddy were still farther north, and had not yet been reached." Dr. Griffiths was astonished at the size of the river above Mandalay, and expressed the belief that it is probably "an outlet from some great river which drains an extensive tract of country."

Incidents of Travel in Somauli-Land.—Mr. F. L. James, while traveling in the Somauli country, East Africa, had a serious tax imposed upon him, from a custom of the natives to come to the camp every night to be fed. "They would sit silent on the ground near the camp-fires where our men would be eating, and, though they never asked for food, they always succeeded in getting it given to them." Living among all the Somauli tribes are low-caste tribes: the Midgans, who carry bows and poisoned arrows; the Tomals, workers in iron; and the Ebir, workers in leather charms. An interesting illustration of the faculty of adaptation to the environment is given in the ability of the animals of the country to go without water. The camels on one stretch passed fifteen days without drinking. Sheep are able to go from six to eight days, and the horses of the party several times went three days without water, and without apparent suffering. The arrival of the company at Gesloguby, one of the principal watering-places of the country, created much excitement among the people who were watering their stock. They crowded around the *zariba* in hundreds, "and expressed the greatest amazement at us and our doings. Smoking particularly astonished them, as they thought a pipe was part of our persons, and that the white man kept a fire somewhere inside; and, when one of our party shot a bird, many fell down, while others invoked the protection of Allah." There appears to be a vein of considerable shrewdness among these people. A faction who were opposed to Mr. James's journey found that the British consul-general had received an order from his government after the expedition had started, to stop its departure from the coast; and they made use of their knowledge with an ingenuity which was admirable and gave our travelers much annoyance. A chief of a neighboring nation, the Adone, having received Mr. James, used diplomatic arts which might have become a Gortchakoff to make of him an instrument with which to chastise one of his rivals; and it required all our author's skill to avoid a fight with one or both of the rivals, who, however much they might hate one another, would probably have come together to attack him. Among these Adone, who detest the Somauli, but sell them grain, a man is not looked upon with favor by the women of his tribe till he has killed another, either in a fair fight or by assassination—and assassination is the more common way. This entitles him to paint the boss of his shield red, or to wear a feather in his hair.

The Coming Metal.—It is predicted that aluminum is the coming metal, which is destined to supersede iron. It is the most abundant metal in the earth's crust, and is not exceeded in usefulness. It is the metallic base of mica, feldspar, slate, and clay. It is present in gems, colored blue in the sapphire, green in the emerald, yellow in the topaz, red in the ruby, brown in the emery, and so on to the white, gray, blue, and black of the slates and clays. It has never been found in a pure state, but is known to exist in combination in nearly two hundred different minerals. Corundum and pure emery are very rich in aluminum, which constitutes about fifty-four per cent of their substance. The metal is white, and next to silver in luster; it is as light as chalk, or only one third the weight of iron, or one fourth that of silver; is as malleable as gold, as tenacious as iron, and harder than steel. It is soft when ductility, fibrous when tenacity, and crystalline when hardness is required. It melts at 1,300° Fahr., or at least 600° below the melting-point of iron, and it neither oxidizes in the air nor tarnishes in contact with gases.

New Chemical Elements.—We are indebted to Professor H. Carrington Bolton for the following interesting table of new elements announced since 1877:

Date.	Name.	Source.	Discoverer.
1877....	Davyum	Platinum ores	Sergius Kern.
	Neptunium	Columbite	Hermann.
	Lavœsium	Pyrite	Prat.
	Mosandrum	Samarskite	J. L. Smith.
1878....	"New earths"	Unnamed mineral	Gerland.
	Philippium	Samarskite	Delafontaine.
	Decipium	Samarskite	Delafontaine.
	Ytterbium	Gadolinite	Marignac.
	"X."	Gadolinite	Soret.
1879....	Scandium	Gadolinite	Nilson.
	Norwegium	Gersdorffite	Dahll.
	Samarium	Samarskite	Lecoq de Boisbaudran.
	Uralium	Platinum	Guyard.
	Barcenium	Misapprehension	Editor Wagner's Jahresb.
	Thulium	Gadolinite	Cleve.
	Holmium	Gadolinite	Cleve.
	Columbium	Samarskite	J. L. Smith.
	Rogerium	Samarskite	J. L. Smith.
	Vesbium	Lava	Scacchi.
1880....	Comesium	....	Kaemmerer.
	$Y\alpha$ and $Y\beta$	Gadolinite	Marignac.
1881....	Actinium	Zinc-ores	Phipson.
1882....	Di β	Gadolinite	Cleve.
1883....	Nameless	Platinum ores	Th. Wilm.
1884....	Idunium	Lead vanadate	Websky.
1885....	Neodymium	Didymium	Welsbach.
	Praseodymium	Didymium	Welsbach.
	$Z\alpha$	Didymium	Lecoq de Boisbaudran.
	$Z\beta$	Didymium	Lecoq de Boisbaudran.
1886....	$Z\gamma$	Terbia	Lecoq de Boisbaudran.
	Germanium	Argyrodite	Winkler.
	Austrium	....	Linnemann.
	Dysprosium	....	Lecoq de Boisbaudran.
	$D\alpha$	Didymium	Crookes.
	$S\beta$	Samarskite	Crookes.
	$S\delta$	Samarskite	Crookes.
	$G\alpha$	Gadolinite	Crookes.
	$G\gamma$	Gadolinite	Crookes.
	$G\delta$	Gadolinite	Crookes.
	$G\epsilon$	Gadolinite	Crookes.
	$G\zeta$	Gadolinite	Crookes.
	$G\eta$	Gadolinite	Crookes.

Forest Devastation in Japan.—We are permitted to publish the following extract from a private letter from Dr. Heinrich Mayr, who is now in Japan, in the course of a journey round the world: "The disappointment in regard to forests in Japan which I experienced was keen. The Japanese have sent out many students to Europe to study forestry, and have, therefore, the reputation of possessing forests; but nothing of that: the mountains are bare, and the forests burned down, just as they are in the eastern part of the Rocky Mountains. Americans might take a fearful warning in regard to the future prospect of their great West; only the landscape will be still more desolate there, because the land is so divided into small holdings that no forest will be raised. Volcanic eruptions in Japan have buried, a hundred or more years ago, whole forests of "Sooghee," as the Japanese call their species of Sequoia. They are again dug up, and people wonder at their size, and the fine grain of the wood that has become gray, for which enormous sums are paid for cabinet-work; but they are not

practical enough to consider that a careful culture might now cover the mountains again with the same wealth. Perhaps, already, in fifty years, America will have reached the same stage; a few monsters of the forest will be admired, and it will hardly appear credible that the ancestors in their greed and ignorance burned down these priceless treasures for an ephemeral gain, and even where not the slightest gain could be obtained by the wanton destruction. The United States possess still the finest forests of the globe, but in the land of haste, hurry, and greed, anything which can not be turned into money at short notice is destroyed. A little more forethought might benefit not only the future but also the present generations. The climate of Japan is not quite so fine as that of the Western United States, but similar results will follow similar causes. Where the land, freed from forests, is used for agricultural purposes, this forest destruction has a fair excuse; but, where enormous tracts of land are denuded for stock-raising, the very means will defeat the end: stock can not be raised without water, and water will not grow; and, with the disappearance of moisture and forests, hard, tough, varieties of grass will alone cover the mountain-slopes. Japan is the land of inundations, and the effects of forests upon moisture are here most strikingly illustrated. Every thunder-shower sends its whole quantity of water without delay to the rivers and the sea, and within a few hours a mountain-valley has seen a dry channel, a raging torrent, and a little brook occupying the same bed; thousands of acres of good land along these numerous mountain-streams can not be cultivated, because the forests are lacking which would retain the moisture and allow it only gradually to seek the river and ocean. We can not realize enough the consequences of forest destruction. But even arbor-days are only a small remedy; the state alone can own large tracts of successfully cultivated forest-land."

Cultivation of Liquorice.—The State Department has published a collection of consular reports on "The Liquorice-Plant and its Cultivation in Various Countries." In England the plant is cultivated in a sandy, loamy soil, the chief requisite of which is that it should be deep enough to allow the roots to get a good length. A manuring is given the ground at planting, and the crop is gathered in three years and a half afterward. The plants do better, after the first season, in a hot, dry summer. They are not harmed by frost, or afflicted by any worm or parasite. The soil between the rows may be cultivated in other plants during the first two years. The grower plants a fresh crop in the spring of each year, and in the fall of the same year harvests the one of three years and a half's growth. In harvesting, a deep trench is dug, to expose the roots without injuring them, and the whole plant is carefully taken out. Liquorice grows wild in Spain, but requires eight years to reach maturity. Where it has once taken root, it is almost impossible to eradicate it. It exhibits many varieties, in the color of the bark, the proportions of saccharine elements and starch, and woodiness. The ground is pulled at intervals of three, four, or five years, according to circumstances, by digging trenches and pulling all visible stalks as long as possible, until they break. The plant is also found and gathered in Asiatic Turkey, Greece, Italy, Sicily, etc.

Condition of the Oceanic Abysses.—Mr. John Murray, director of the Challenger publications, presents, as a summary of results, that in the abysmal regions which cover one half of the earth's surface, and which are undulating plains from two to five miles beneath the surface of the sea, we have a very uniform set of conditions. The temperature is near the freezing-point of fresh water, and its range does not exceed seven degrees, and is constant all the year round in any locality. Sunlight and plant-life are absent, and, although animals belonging to all the large types are present, there is no great variety of form or abundance of individuals; change of any kind is exceedingly slow. In the more elevated portions of the regions the deposits consist principally of dead shells and skeletons of surface animals; in the more depressed ones, of a red clay mixed with volcanic fragmental matter, the remains of pelagic vertebrates, cosmic dust, and manganese-iron

nodules and zeolitic crystals. It has not yet been possible to recognize the analogues of the deposits now forming in the abysmal regions in the rocks making up the continents, but it is quite otherwise in the areas bordering on the continents. Almost all the matter brought down to the ocean in suspension is deposited in this region, which is that of variety and change, with respect to light, temperature, motion, and biological conditions. It extends from the sea-shore down, it may be, to a depth of three or four miles, and outward horizontally from sixty to three hundred miles, and includes all partially inclosed seas. Plants and animals flourish luxuriantly near the shore, and animals extend in relatively great abundance down to the lower limits of the region. Here we find now in process of formation deposits which will form rocks similar to those making up the great bulk of continental land. Throughout all geological time the deposits formed in this border or transitional area appear to have been pushed, forced, and folded up into dry land, through the secular cooling of the earth and the necessity of the outer crust to accommodate itself to the shrinking solid nucleus within. The changes in the abysmal region, though great, are not comparable with these. The results of many lines of investigation seem to show that in the abysmal regions we have the most permanent areas of the earth's surface.

Rivers underground.—General R. Maclagan, describing the rivers of the Punjab before the Royal Geographical Society, remarks that, when the measure is taken of the water in a river flowing in a wide channel in soft soil, we do not at any time get the whole of it. We measure what is flowing above the bed, but there is more beneath. It sinks down till retained by some impervious stratum, and may become something like a second river flowing under the larger one which we see. It happens sometimes that the whole of a small stream sinks into porous soil and disappears, and, if a retentive stratum which it meets beneath comes out to the surface at a lower part of its course, the filtered water will pour out and become a surface river again, after the ordinary manner of streams. The experiment has been made on the Jumna of shutting off the whole visible river with a weir and turning it into the canals on either bank. A few miles below, the water trickles down into the bed again, and farther below there is a river as before. In most river-beds, like those of the Punjab, when they are left dry at the sides in the low season, water is to be got under the dry bed, as well as under the river, and usually at no great depth. Plenty of water can often be got by scooping a mere hole. The water-supply of Lahore is pumped from wells sunk in the bed of the Ravi. The water which sinks under the beds of these great rivers finds a wide field of hidden usefulness open to it when it gets beneath. Spreading abroad it meets, and helps to make, the great underground lakes and springs on which every country so largely depends. In the rainless tract around the meeting of the rivers in the south of the Punjab, this underground reserve of water is abundant and near the surface. In the distribution of the reserves there are great variations, according to the varying extent, form, and positions of the dividing walls of impermeable soil. The admission of water to new canals is commonly followed by the rise of the water-level in wells within a certain distance on either side. Like the Mississippi, the Indus has in a part of its course raised its bed by the deposition of silt, so that for nearly four hundred miles it runs on an embankment made by itself, with long gentle slopes on both sides down to the general low level of the country. As along the Mississippi, the country is protected by dikes, and danger is apprehended in flood-times from crevasses.

Advantages of Sea-Voyages.—A medical writer in "Chambers's Journal" makes a warm recommendation of sea-voyages as a means of restoring health and strength. Among the chief advantages of a voyage are the perfect rest and quiet it secures. It is sure to take the passenger and keep him for a time out of the reach of all home annoyances and home drudgeries, and in many cases out of mind of them. He "has only to eat, sleep, and live. The strain of life is withdrawn. The wheels of existence move easily and with lessened friction. The incessant emulation, the keen anxieties, the

worrying cares which beset modern commercial and professional life, are as things that have never been." Another important advantage lies in the pure atmosphere and the long hours of uninterrupted sunshine and air that may be obtained, particularly in the warm latitudes, where the passengers may almost live on the deck. Other advantages lie in the equability of the climate, which varies but little from day to day, with freedom from chill, the saline particles in the air, the abundance of ozone, and the high average range of the barometer at sea. Drawbacks are not wanting, and they consist principally in the monotony of life on shipboard, the paucity of amusement and distraction, and the occasional discomforts of severe weather. The longer the voyage, provided it fall short of producing intolerable *ennui*, the greater the gain to health. Hence a sailing-vessel may be preferable to a steamer. A sailing-vessel has the further advantage that its progress being less rapid, the changes of climate in north and south voyages are more gradual than on the steamer. Sea-voyages are recommended to those who are suffering from affections of the respiratory organs, and to those who are simply overworked and in need of rest and change. But "those far advanced in disease, from whatever cause, and those threatened with melancholia or other form of insanity, should avoid a long sea-journey."

Fauna of Deep-lake Bottoms.—Although vegetation appears to be absent, the fauna of the depths of the Swiss lakes, considering as at great depths all points over seventy-five or eighty feet below the surface, is rich and abundant. All the deep-water classes except echinoderms are more or less perfectly represented, and, while the number of species is not very great, the types are remarkably varied. The individuals composing this fauna are generally of smaller size than those of corresponding littoral species; they are more opaque than in the pelagic fauna, and are seldom colored, for they live in a darker medium than the sea; and they are poor swimmers, and have no organs of attachment. Some of these animals exhibit curious features of adaptation, among the most remarkable of which is the smallness or entire absence of the eyes in some species. But this defect is far from being uniform. Thus, while some animals may be found with good eyes at the depth of one thousand feet, others will be found totally blind at one hundred feet, where there is still some light. This curious fact is explained by Dr. Plessis by supposing that an emigration has been going on from an extremely remote period and is still continuing, from the littoral and pelagic regions to the deep zone. The species which have most recently performed this emigration have not yet lost their eyes, while the species that went down in earlier times have had them atrophied, and have transmitted the defect to their offspring, even in regions where there is still light. This view is confirmed by the fact that we can find in the same species individuals wholly blind, others with their eyes in the way of atrophy, and others with sound eyes, but small, according as they may have descended from stocks that have emigrated at different epochs. Another feature in which adaptation is shown is in the organs of respiration. There are larvæ of Diptera in the lake-bottoms having a tracheal system, like those of surface insects, opening without by stigmata; but instead of air these tracheæ are filled with water. The Lymneæ of the bottom exhibit the same peculiarity. Forel always found their pulmonary sac filled with water. But they resume their normal method of respiration with a surprising facility as soon as they are placed in contact with the air, and this without appearing to suffer in the least.

School-Life and Chorea.—Dr. Octavius Sturgis, of the Westminster Hospital, London, has called attention to certain events and circumstances of school-life which during the year have within his own experience given origin to St. Vitus's dance. A patient whom he has had under treatment, a girl eleven years old, had been observed, before her chorea began, to be "restless at night, crying out in her sleep, or sitting up and rambling about her lessons. She was always eager to be at her books, and would bring home school-work to be prepared overnight. Owing, however, to the pressure of domestic matters, the lessons were often left

undone, and as a consequence the girl was 'kept in' and otherwise punished. For some time the strange movements of the child had been noticed at home, but nothing was thought of them, and no change was made in the routine of her life. It was ascertained that there had been no intentional unkindness either at school or at home. The child was anxious to learn, but too little allowance was made for her scanty opportunities of mental culture, and she thus fell into undeserved disgrace." The malady is one which develops slowly, and is very rarely recognized at the beginning. "The rule is that for weeks or for months what is really disease is taken for carelessness or perversity, and a condition which needs for its cure the utmost tenderness and allowance is thus aggravated by repeated punishment."

NOTES.

The fifth volume of the "History of California," in the series of Bancroft's Works, now just published, brings the record up to the discovery of gold in 1849. The publishers announce that they have been busily engaged in remanufacturing the stock that was consumed in the fire of April 30th, of which the edition of the present volume was a part, and that the delay and inconvenience caused by that disaster were only temporary.

The editor of the Johns Hopkins "University Studies in Historical and Political Science" proposes a series of extra volumes to appear in a style uniform with the regular studies, but otherwise independent of them. The volumes will vary in size from 200 to 500 pages, with corresponding prices. The first volume will be published early in the season, as "The Republic of New Haven"; a History of Municipal Revolution. By Charles H. Levermore, Ph. D. It is a new study, from original records, of a most remarkable chapter of municipal development.

From a series of experiments which he has made upon the amount of water contained in highly lignified plants in various seasons and under varied conditions of growth, Professor D. P. Penhallow has drawn the conclusions that the hydration of woody plants is not constant for all seasons, and depends upon conditions of growth; that it reaches its maximum during the latter part of May or early June, and its minimum during January; that it is greatest in the sap-wood, and least in the heart-wood; and that the greatest hydration is directly correlated to the most active growth of the plant, while lignification and storage of starch and other products are correlated to diminishing hydration.

Professor W. Mattieu Williams infers, from the examination of Count Rumford's "Essay on Gunpowder," that he produced solid carbonic acid in the course of his experiments on the explosive force of that composition. In an experiment with a confined cylinder, the count observed "an extremely white powder, resembling very light white ashes, but which almost instantaneously changed to the most perfect black color upon being exposed to the air." Professor Williams supposes that this white evanescent ash-like deposit was solid carbonic acid. The change to black mentioned by Rumford was caused by the instantaneous evaporation of the acid, causing to be revealed the ordinary black deposit of gunpowder beneath it. The pressure under which the experiment was conducted was 9,431 atmospheres, which is abundantly sufficient to effect the solidification of carbonic acid.

Considerably more than four million persons had been, at the end of last year, insured against sickness under the German law of compulsory insurance. At the beginning of 1886 the compulsion to insure was extended to the whole administration of the post, railway, and telegraph, and to all trades connected with transportation; and a movement is on foot to extend the principle still further. The introduction of the system has not led to any diminution in the number of friendly societies or trades-unions, but many of them have had an enormous increase.

Dr. W. J. Graham, of Grafton, Dakota, has propounded a new theory of the origin of the alkali which is more or less abundant on the Western plains. He derives it from his observations, during several years' residence, of the soil, water, and atmosphere of the country. It is that the basis of the alkali is common salt, which is derived from a rock-salt formation underlying the region, by permeation to the surface, where it undergoes the chemical reactions which give it its apparent form and composition. Dr. Graham also believes that the alkali will afford a valuable and really inexhaustible fertilizing material.

Professor Brown-Séquard was, on the 21st of June, elected to the Section of Medicine and Surgery in the French Academy of Sciences, in place of M. Vulpian, who has been made perpetual secretary. Professor Brown-Séquard received thirty-six votes, to nineteen given for M. Germain Sée.

Professor L. Weber relates, in a German periodical, that during a thunderstorm at Ribnitz, in Mecklenburg, the lower pane of a window on the first floor of a house was broken by lightning, and a jet of water was thrown upward through the hole to the ceiling, with such force that a part of the ceiling was broken down, and other damage was done. The hole in the window was like a bullet-hole, with radial cracks. Some cigars on a table, that was broken by the fall of the ceiling and the water, were carbonized. The origin of the jet of water, is not satisfactorily explained.

Mr. Thomas Wardle, of Leek, England, has been to India and examined the cultivation of the silk-worm and the means still in use for reeling the silk there, with a view to suggesting means for improving them. Although the reputation of Indian silk has greatly declined during the last twenty-five years, he is satisfied that its fiber is quite equal to that of Italian silk, and that improvement in methods is all that is required. The Italian threads are, however, four times as long as those of the Indian cocoons. The profitableness of the silk-growing business is shown by the fact that the zemindars derive their very highest rents from lands devoted to it.

An ancient—probably prehistoric—British vessel has been found at Brigg, in Lincolnshire, England, in the course of making an excavation of the ground for a new gas-holder. It is cut out of a solid piece of wood, and measures forty-eight feet in length, fifty-two inches in width, and thirty-three inches in depth. It is in a remarkably good state of preservation, because, probably, it was imbedded in a clayey soil which excluded the air. An ancient wooden causeway was discovered in the same neighborhood a few years ago. It was made of squared balks of timber fifteen feet long and ten inches square, which had been fastened to the earth by pegs driven through holes in the ends.

Mrs. Bryant has communicated to the Anthropological Society the result of some tests which she has made of the powers of perception, inference, and imagination, of a class of girls of about thirteen years of age, by asking them to describe some particular object from memory. The most noteworthy result was that due to a faculty which the author calls emotionalism. The emotional girls, who, in their descriptions, used such adjectives as "beautiful," "lovely," "sweet," etc., showed deficiency in more valuable traits of character; and it seemed that in those cases emotion superseded thought. Such tests as these might prove valuable in education and the choice of a profession, and, perhaps, in civil-service examinations.

MM. C. Weigett, O. Sacre, and L. Schwab, have investigated the effects on fisheries and fish-culture of sewage and industrial waste waters, and find them very damaging. Chloride of lime, 0·04 to 0·005 per cent chlorine, exerted an immediately deadly action upon tench, while trout and salmon perished in the presence of 0·0008 per cent of chlorine. One per cent of hydrochloric acid kills tench and trout. Iron and alum act as specific poisons upon fishes. Solution of caustic lime has an exceedingly violent effect upon them. Sodium sulphide, 0·1 per cent, was endured by tench for thirty minutes.

Mr. John Urie, of Glasgow, Scotland, has invented a new method of photographic silver-printing by machinery. A ribbon of paper is caused to travel by clock-work beneath a negative, which is let in to the top of a light, tight box. Above the negative is a powerful gas-burner, which is turned up and down automatically, as the paper pauses in its passage every few seconds. The strip of paper, which, at the end of a few minutes, bears perhaps twenty latent images of the negative, beneath which it has been traveling, is then developed by a suitable chemical agent to make those images visible.

M. Perrotin has reported to the French Academy of Sciences concerning the observations he has been making upon the "canals" of Mars with the great equatorial which has just been mounted at the Nice Observatory. These are a feature of the planet which was first observed by M. Schiaparelli, and consist of grooves about twenty-five kilometres in width, having perfectly parallel borders, which are stretched across the Martian continents, between the seas. Nothing like them exists on the earth or the moon, or any other planet, so far as has been observed. Consequently, it is impossible to conceive any satisfactory explanation of their existence. M. Perrotin's observations have been verified by MM. Trépied and Thallon.

Besides the caves at Gomanton, in North Borneo, of which we lately gave an account in our Miscellany, the edible birds' nests are produced in caves in islands off the coast of the Malay Peninsula. The caves belong to the Siamese Government, and are farmed out to contractors. The harvest is during March and April. The nests are collected as soon as they are built, and before the swallows have begun to lay their eggs. The birds build second nests, and these are taken away; but the third nests are left. The caves are accessible only by means of rattan ladders, and the nests are collected from the rocks by means of rattan galleries and stagings. The Siam-

ese caves are wilder and more dangerous than those at Gomanton.

The use of gas cooking-stoves is increasing in Great Britain. Many of the Scottish gas companies now let out the stoves at a cheap rate. Dr. Stevenson Macadam, speaking of gas-cooking in its sanitary aspects, says: "The wholesomeness of the meat cooked in the gas-stoves must be regarded as beyond doubt. Gas-cooked meat will be found to be more juicy and palatable, and yet free from those alkaloidal bodies produced during the confined cooking of meat, which are more or less hurtful, and even poisonous." A joint cooked in a gas-oven weighs heavier than the same joint cooked in a coal-oven, because the juices are more perfectly preserved in it.

Professor W. Mattieu Williams calls attention, in "Science Gossip," to the danger of the extermination of the sole—one of the best of food-fishes—by trawling. The vessels, which are numbered by the thousand, sweeping the sea-bottom with a track as broad as their own length, scour each an acre an hour. If they are steamers, the effect is vastly magnified. Forty years ago, when the "Silver Bank" was a fresh fishing-ground, soles were retailed in London at twopence a pound, and enormous specimens were abundant. Gradually the size diminished and the quantity declined till the harvest consisted chiefly of "slips." Now the Silver Bank is practically ruined, and the price of soles has risen about one thousand per cent.

M. Bréal, a French writer on educational subjects, remarks, in his essay on the method of acquiring foreign languages, that when a person goes to a foreign country to learn the language he rarely succeeds; but, if he goes to pursue some particular profession or business, he learns the language rapidly and thoroughly—first the language of that business, then the language of ordinary intercourse, and so on step by step, in the order of nature. Thus it is the natural method that prevails.

The "Lancet" makes a distinction between what it calls the use and the abuse of tobacco. The man who can say, "I always know when I have smoked enough—if I go beyond the just limit I lose my power of prompt decision," is one, it suggests, who had better not smoke at all; but "a moderate use of tobacco soothes the senses, and leaves the mental faculties free from irritation, and ready for calmly clear intellectual processes. When this is not the effect produced by smoking, the "weed" had better be eschewed.

Mr. George J. Romanes, having observed a rat, under circumstances in which it should have been badly frightened, manifest great savagery and voraciously devour its companion, persisting in biting it till the last moment of consciousness, has been led to inquire whether the case is one of peculiar ferocity, or of emotional insanity produced by extreme terror. He wishes to know how wild rats ordinarily behave when shut up in a cage together.

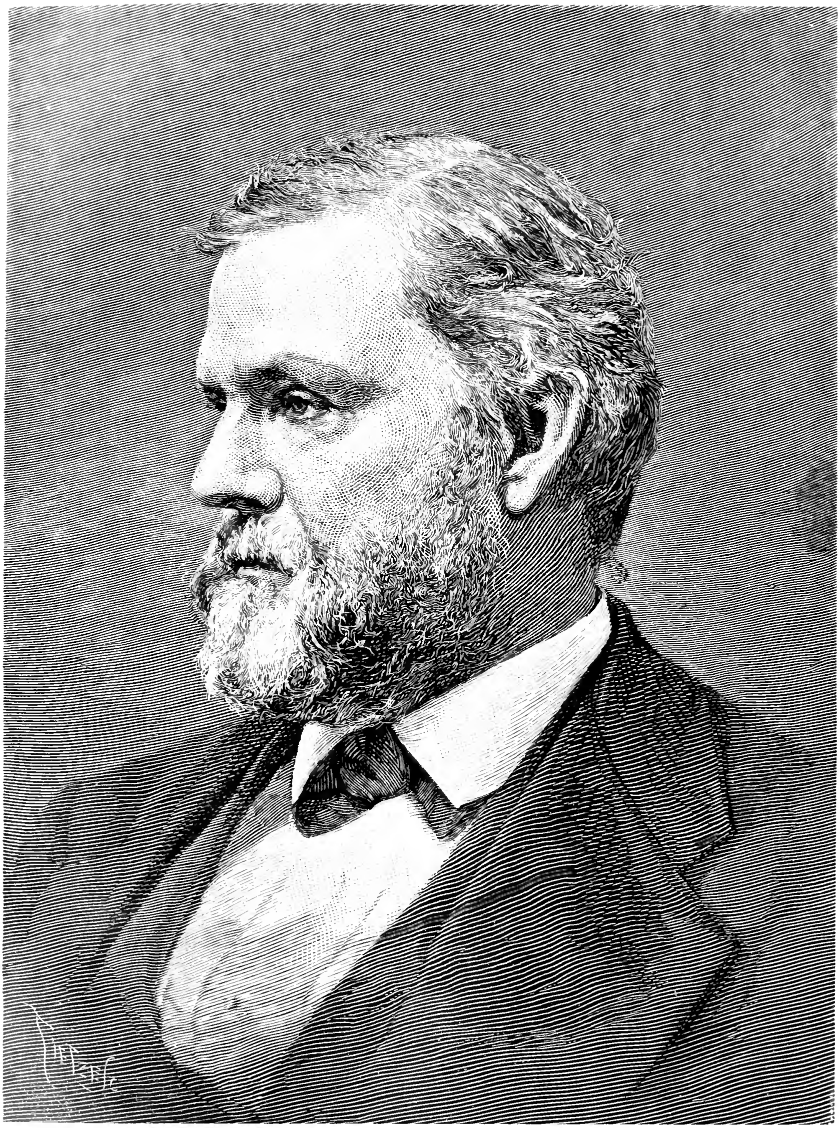
It is definitely asserted by the engineer of the Suez Canal that the annual mean level of the Mediterranean at Port Said is the same as the annual mean level of the Red Sea at Suez; and that, according to the observations of the Panama Canal Company, there is no difference of moment between the levels of the Atlantic at Colon and of the Pacific at Panama.

OBITUARY NOTES.

Professor William Ripley Nichols, of the Massachusetts Institute of Technology, died in Hamburg, Germany, July 14th, in the fortieth year of his age. His death was caused by a disease of the lungs, from which he had been suffering more or less for four or five years. He was graduated from the Institute in 1869, in its second class, and was shortly afterward appointed Professor of General Chemistry in it. He was the author and compiler of several text-books on general and inorganic chemistry. He made a specialty of water analysis, in which he acquired a high reputation for accuracy and probity; he studied the ventilation of railroad-cars and the effect of the atmosphere of smoking-cars, and did much work for the Massachusetts State Board of Health.

Professor Sheldon Amos died at Ramleh, near Alexandria, Egypt, January 3d, at the age of fifty years. He was the youngest son of the late Andrew Amos, Professor of Law at Cambridge, and was called to the bar in 1862. He was for several years Professor of Jurisprudence at University College, London, but spent many of the later years of his life abroad, in Australia and Egypt. He was for several years, and till his death, English Judge of the new Egyptian Court of Appeals. He was the author of several legal treatises.

Dr. William King, Emeritus Professor of Geology, Mineralogy, and Natural History in Queen's College, Galway, Ireland, died June 23d, in his seventy-ninth year. He was elected to his professorship on the foundation of the Queen's Colleges in Ireland, in 1849, and filled it actively till 1883.



JOHN NEWTON.

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THE DISTRIBUTION OF WEALTH.

By CHARLES S. ASHLEY.

ON a railroad-train one afternoon my conversation with a fellow-traveler, a successful merchant, turned on the vast fortunes which have been accumulated and transmitted during the present generation. "Where is this thing going to end?" said he. "Cornelius Vanderbilt left his son William about $50,000,000; eight years later William dies, and leaves $300,000,000. In the lifetime of his sons this ought to increase to $600,000,000;* and in the lifetime of *their* sons who can tell how much the Vanderbilt fortune will amount to? Legislation ought to put a stop to this business." He spoke very earnestly, his face assuming a tense, stern expression, as if he were confronting some personal enemy. Other persons in the car overheard and testified their interest in the subject by joining us, some of whom showed equal or greater vehemence in what was called the cause of labor; and the general sympathy seemed to be with the remarks I have quoted.

These persons, if I mistake not, may be said to represent a very general sentiment existing in this country—a sentiment almost completely pervading the laboring masses † and certain other special classes, such as the clergy and the women, and prevailing less extensively among our professional and merchant classes and our scholars. Newspapers advocating progressively severe income-taxes, the compulsory division of property at the death of the owner in ways insuring diffusion, the assumption of state control of telegraph lines, and the regulation of other corporations in such a manner as to insure a mini-

* These figures, uttered in actual conversation, are of course inaccurate.

† "The Toilers throw Theory and Sophistry to the Dogs, and take the Settlement of the Question into their own Hands." (Heading in "Toledo News" (labor paper), March 13, 1886.)

mum of profits, are too common to admit of mention. In high-class periodicals, too, like "The Century," we find plentiful manifestations of the same spirit. Sometimes, as in the article "Danger ahead," published in a late number of that magazine, the fear of violent revolution shows itself in the feverish manner of the argument, and may fairly be counted as the chief source of the opinions expressed; but, again, as in the recent papers of Washington Gladden, we find a calm discussion of socialism and conclusions favorable to it arrived at with no obvious bias. And in the pages of the most orthodox political economists we observe a kindred tendency. In Mill's "Political Economy" there is no exhaustive examination of the unequal distribution of wealth; but the tone of the whole work is, I think, expressive of regret that inequalities should be so great as they are. While considering inheritance he commends laws enforcing the division of accumulated wealth at death.* Elsewhere he denies that the proportioning of remuneration to work done is really just, except so far as the amount of work is a matter of choice; it is only "highly expedient."† This shows his feeling toward the existing system, and nearly all political economists exhibit a like feeling. And even in Mr. Fiske's "American Political Ideas," despite the magnificent pæan on our "manifest destiny," which is in effect a eulogy of our comparatively free economic system, we read with sympathetic regret of the progress of a typical Massachusetts village from a state of comparatively equal prosperity and intelligence to that of a manufacturing town, where the distance between the highest and lowest becomes in nearly all ways so great. Our affections incline toward this primitive homogeneity; our ideas have been largely molded by it and by the great struggle against slavery, with which we naturally, though erroneously, associate definite class divisions, to which we are obviously tending. Our feeling for the past, or rather our adaptation to it, joins with apprehension of the future to make us fear any further departure from homogeneity, and we are impelled along rather by the action of blind economic forces than by any one's wish. A perception of our economic tendencies voices itself roughly in the very inaccurate saying that "the rich are getting richer and the poor poorer," which is the burden of the works of Henry George and most of the socialistic writers; and the united action of society is invoked to remedy the unfair operation of economic laws.

Such being the ideas more or less vaguely prevalent, it may be interesting to examine—1. What has made possible the acquirement of the great fortunes of the present generation? 2. Will the favoring circumstances continue? 3. How should we regard the holding of millions by a single man and its inheritance by his family—perchance by a single son who could never have gained such wealth for himself?

* Mill's "Political Economy," vol. i, p. 289, American edition.

† Ibid., vol. i, p. 272. I can not reconcile this doctrine with the utilitarian philosophy.

Notwithstanding the interesting nature of these questions, they are seldom discussed, and Mr. Sidgwick is almost alone in a systematic examination of the third topic. Keeping in mind that no age has seen such vast accumulations of private wealth as the present, we take up the questions in order :

I. At first sight it is not clear why some few men apparently not much distinguished from the rest should gain such disproportionate rewards in wealth and power. Nearly all our great millionaires began as poor men, and in a few years they are possessed of incomes up among the millions. Many find this plainly unjust, and a condemnation of our entire economic system. Even though the laborer has also gained both in money-wages and in their purchasing power, as well as in decreased hours of labor, this is not sufficient ; his share in the increase is unfair.* The capitalist gets an increasing share of the produce, and grinds the faces of the poor.

It might dampen the ardor of these reformers to reflect on the well-known fact that the average remuneration of capital in this country is not more than five per cent, as we may see in the fact that money can be borrowed on unquestioned security for much less. Here, however, we have to account for the extraordinary cases. There is nothing particularly difficult about it. As in armies we find man set over man and grade over grade, despite apparent equality, so in an age of commercial militancy, of universal competition and rapid transition, we find that a similar inequality is created.

For though industrialism is in many ways to be sharply contrasted to militancy, they agree in this—that in each there is a struggle for existence. And when by improvement in the means of competition this struggle becomes more constant and severe, and division of labor arises through the necessity of each to rely on his special power, there arises the same need of management and direction, and the same high reward is necessarily paid for it. Thus, the democratic civilization of our early history, whose ideal was that every citizen should own at least " forty acres and a mule," has given way to the modern militant industrial system. The application of steam to transportation led to universal competition, in which the strong waxed stronger and the weak became still weaker, at least relatively, or else sought pastures new. Man was set against man, town against town, and State against State ; for States are competitors for the hire and business of the great world as men are competitors for the service of employers or in commerce for the service of their communities.† The men and towns and coun-

* Mr. Gladden, in " The Century " for March, 1886, p. 739. This mistake, which Mr. Gladden apparently makes his own, plainly springs from overlooking the fact that the share of labor in the produce is not simply the wages of employés directly in view, but the wages of all those, however distant, who contribute to it. *The capitalist's expenses are the remuneration of labor.*

† Socialistic writers regard this state of things with horror. It is curious to note,

tries best prepared for the new conditions have taken the lead and reaped the reward. The nations best qualified by habits of labor and enterprise for this vast competition were England and the United States. Among cities New York and Chicago have outstripped Norfolk and New Orleans. Among individuals certain industrial princes have been evolved, and these are our millionaires. On the face of the matter it is not apparent why Turkey or Spain has not as much claim on the increased wealth of the world, so large a proportion of which has been gained by the United States, as an ordinary citizen has on the profits which Mr. Gould derives from his telegraph system. If there were forty or fifty such countries situated near each other and capable of combining, very likely they would resolve that we had more than we ought to have, and compel us to disgorge our ill-gotten gains.

It is now apparent that the position to be here taken is that in the normal and usual case wealth is gained by doing a corresponding share of the world's work ; and it may further be said that the amount of individual gain is no adequate measure of the public gain. A vague idea prevails that the great millionaires have gained their wealth through some mysterious and illegitimate trickery.* As very few are aware of the beneficial operation of speculation, which is really an insurance to the producer against undue fluctuation in the price of the product, operations in Wall Street lend some support to this idea. Then, too, the ordinary formula for profits given in books on political economy (profit = wages of superintendence + interest + recompense for risk) hardly aids us in understanding American fortune-getting as a normal process. This formula really means that profits have a tendency to fall or rise to the level stated. With actual profit, particularly when realized in a new commercial age, it has very little to do. The fact is that profit is based on the *value* of the service done the public, in the public estimation. For particular cases a more accurate formula is, profit equals the total money value of the service rendered, less expenses and the public profit therein. In small business enterprises the flow of capital into very profitable investments is very rapid, at least in all except new communities. But it has not been so with large enterprises. The immobility and mismanagement of capital have been so great that a high premium has been put upon unusual foresight and sagacity during the advent of the age of railways. The history of the Western Union Telegraph Company, and of the fortune of the first Cornelius Vanderbilt, furnish excellent illustrations : we choose the latter.

however, the complacency with which they regard displays of brute force, either under the form of war or riot, or in the shape of a law backed by the superior force of society.

* The Rev. Mr. Abbott shows this feeling in his article in "The Century" for November, 1885, where he assumes that no man's service can be worth more than a million a year to the public.

When "Commodore" Vanderbilt began the railroad business in 1863, the railroads of the country had not emerged from the character in which they were originally conceived—they were improved turnpikes chiefly for local business. Rivalry with the canal for the transportation of heavy articles was hardly thought of. The shipment of freight for any great distance was a matter of no small expense, delay, and risk. In short, the present railroad system of the country, by which Dakota exchanges her wheat, produced at an expense of about thirty cents a bushel (instead of about sixty-five in New York), for Eastern manufactures, produced under equally advantageous circumstances, was yet embryonic. In the transformation of local lines into highly organized and efficient systems, which give the public much better service at much lest cost, two men were especially conspicuous—Cornelius Vanderbilt and Thomas A. Scott. More discerning than the rest, these men saw the need and the possibility of improvement, and organized the New York Central and Pennsylvania systems. The ultimate result is well known. Rates from Chicago to New York in 1868 were from five to ten time as high as at present,* and the service given was in every way inferior to that now furnished. But this in itself is a comparatively trifling matter. Without the cheap transportation thus furnished, the world would be without the major part of the rich product now annually pouring from Texas, Kansas, Dakota, and the rest of our inland territory. The earnings of every man in the United States and England have thus been incraased. Even the Eastern farmer has been benefited, paradoxical as it may seem; for Mr. Atkinson has shown that the value of the product of Massachusetts farms has been greatly increased by the fact that the farmer no longer has to raise his own cereals, but can devote his entire farm to perishable fruits, etc., which bring high prices.† Large as were the gains to the great corporations thus organized, and to Mr. Vanderbilt and his compeers, they were almost infinitesimal when compared with the gains of the public.

This is the outline of the history of the Vanderbilt fortune. The substance of it is, that his organizing and constructive ability enabled him to offer a great boon to the public, and he succeeded in securing a share of the result of his labor—a much smaller proportionate share than the laborer ordinarily receives. His reward was based on the value of his service and not on his expenses. Similarly with other branches of business. The manufacturer and merchant most prompt in meeting the new economic conditions outstripped competitors, and the public were benefited, notwithstanding the discomfiture of the less efficient.

Differences in practical ability to appreciate the new world should prepare us for corresponding differences in the theoretical under-

* Hadley's "Railroad Transportation," p. 93.

† See his admirable pamphlet, "The Railroads of the United States."

standing of it. And, indeed, the political economists, reckoning in all who write on economic topics, are so far apart that the authority of their science has greatly declined in the past twenty years, owing to the general doubt as to what the science really stands for. In the early part of this century our politicians were probably our best economists. Now the difference between the leading politicians who make our laws and the men who write is appalling or grotesque, as we may choose to look at it. Looking over the whole ground, a physicist would say that the inventions of the present century were forces falling on units already unlike, and they necessarily led to increased divergence in wealth and intelligence. Dissimilarity once initiated bred dissimilarity. Those successful under the new *régime* were able to combine their capital and undertake large and profitable enterprises. Here, again, appeared differences. Probably a majority of those who so invested have either lost money or have at least failed to make much, as we may be sure from the fact that the average return on capital actually invested in railroads in this country is less than four per cent; and, of course, the return to the original undertakers was even less. Others, however, like Mr. Vanderbilt, reaped a rich reward; and thus came increased divergence.

Enough has been said, I think, to make it clear—and indeed it is obvious at first thought—that the golden opportunities seized by our business chiefs have been offered principally because the past age has been one of enormously rapid transition. Very few men were adapted to the new circumstances, and those few necessarily reaped a large profit. Such violent and disorderly transitions are very uncomfortable; and it is to this fact, if the foregoing views are correct, that we must ascribe the manifestations of irritation even among those obviously benefited—manifestations which are to be found in our literature, our universal hurry, and our entire conduct of life.*

II. The second question—Will the circumstances favoring the sudden aggregation of wealth continue?—is thus in large measure answered by the first. It now takes the form, How long will the period of active transition continue? This question naturally divides itself into two others, which may be separately discussed:

1. What is the prospect of new inventions which will have a power of disturbance similar to that already shown by steam and electricity? This is, of course, very hard to say, but we are not altogether without light. No great alteration in methods of business is possible except through improvement in the means of transportation, and through the removal of artificial obstructions to transportation, such as tariffs and other interferences of the government with the

* Our feverish haste struck Mr. Spencer as our leading national trait. And in "The Nation" of August 30, 1883, is a thoughtful and striking editorial, in which it is remarked that discontent, so far from being peculiar to the working class, pervades all classes.

natural course of trade. When the circulatory system of the body politic is complete, the evolution of the body is complete. And, if the discovery of some Keely motor or of some practicable method of navigating the air is made, we shall probably enter on another period of transition as violent as the last. But there is very little expectation of anything of the kind. Unless a "negative gravity," like that in Mr. Stockton's clever story, is discovered, it is not easy to see how even the navigation of the air would effect much change in our system of transportation, for air-ships could hardly carry coal or heavy merchandise. The probability seems to be, therefore, that we have approximated our limit. Subsequent improvements will be matters of detail, such as the extension of existing lines or the perfecting of economical railroad operation. A system under which a piano can be shipped a thousand miles for less than the price charged by the drayman who takes it to the final destination, is hardly susceptible of revolutionary improvements. Producers at any one locality are already practical competitors with the rest in their line of business. No system of transportation, however perfect, can accomplish very much more.

2. When will the violence of the transition brought about by steam and electricity subside? When will the industrial population become adapted to the new environment? When will society cease to pay such high premiums on organizing ability? Clearly when the necessary organization is approximately complete. So long as wealth can be more advantageously employed in unaccustomed amounts or in unaccustomed ways, this premium will be paid and the present phenomena will continue, for owing to the inertia which possesses capital as well as everything else, the demand for it in the particular directions will be greater than the supply, and a rise of price will be the result. Now, it may be said with some confidence that the crisis is already past. In England the year 1845 may be taken as the highest point of the disturbance in departing from the old homogeneous system to the modern division-of-labor system; and in America, probably the year 1869, which witnessed the completion of the Union Pacific Railroad, is a corresponding period. The severity of the financial crises which overtook both countries near the years mentioned seems to indicate the substantial accuracy of this estimate. If this conjecture is valid, we are justified in saying that men are now running a more even race for business success. Differences between individuals in the common business qualities are, of course, quite great; but no one person and no hundred persons so far surpass all others as to cause such results as those seen in the past twenty years.

If, then, we may take the view that the great modern inventions have spent the greater part of their disturbing force, we may conclude that we are passing from a period where "multiplication of effects," or divergence, has been the rule, to one of segregation and equilibra-

tion; or, to express it in more common terms, from a time of disorderly and confused industrial action to one of harmonious orderly organization. The introduction of the new elements into the commercial world changed, as it were, the polarities of our industries. They are still adjusting themselves to the new basis, but the adjustment has now a much more regular and orderly manner than at first. Evidence of the steady progress toward harmonious organization is to be found in the decreasing violence of railroad traffic wars; in the greater caution of the speculating and investing publics; in the development of pools to regulate traffic and production in all industries; and in the slow but steady advance toward satisfactory relations between labor and capital.* All these are parts of a process which we may best call economic segregation, and, rightly conceived, they may give us at least a general idea of the course of our economic evolution.

To attempt particular description of the operation of a given force is hazardous, even in comparatively simple sciences. Much more so is it in sociology. Still, we are forced to look forward as well as backward, and must form some idea of the future operation of what we see working about us every day. In this place, several agencies tending to the diffusion of wealth, or rather its segregation into the hands of comparatively large bodies of men capable of handling it, may be noted. First, and most important, perhaps, come corporations. No one, so far as I am aware, has yet treated of them with any approach to adequacy. Objects of general dislike, they exist rather by their own inherent efficiency than because they are held in any proper estimation. We have, indeed, but to look around us and notice the gigantic increase in their number and power, and in the number interested in or employed by them to see their vast import. A dispassionate view of the subject will, in my opinion, convince a competent person that the general economic function of a corporation is to perform steadily, cheaply, and permanently, a service which an individual can only perform briefly, and with comparative inefficiency. Where corporations can not do this, they are unable to exist; and, in consequence of their permanence, they are able to give lasting employment, and, therefore, more than any other mode of industrial organization, they are apt to give the right man the right place; as we may see in the history of most of our prominent railroad men. And when this process of segregation is complete, corporations will undoubtedly be made up of those who actually perform their service. The immense saving

* Recent strikes and riots are apt to blind us to the progress really made in this respect. The question is hardly in order here; but it may be pointed out (1) that strikes are accompanied with less violence than formerly, as in 1877, for example; (2) that organized bodies like the Knights of Labor are more responsible to public opinion than unorganized labor; and (3) that great advances have been made in particular cases.

and the superior efficiency to be thus gained are apparent; and in the struggle of corporation against corporation, it is evident that this form of organization will be evolved as soon as the honesty and intelligence of the laboring classes will admit of it. Next, we may specify organizations very like the foregoing in principle, but which are commonly regarded with as much favor as corporations with the reverse. We refer to co-operative associations. In communities where there is little change from year to year, these may assume considerable importance. Then come labor organizations. When trades-unions were first prominently introduced, the general feeling was one of fright; and in this country there is still some uneasiness as to the working of our great labor organizations. Here they can only be noticed as a part of that segregation everywhere going on. General considerations thus lead us to a belief in their beneficent results, in spite of the many mistakes which they have committed, and will continue to commit. Next, we may recall that all unequal distribution tends to die out, unless, as has been so conspicuously the case in the last twenty years, the aggregation of property in single hands gives a great advantage in its management. Inheritance is a perpetual force for equal distribution. It may, indeed, be counteracted by stronger forces, either political, as in the feudal system, or commercial. But the management of combinations of property is now so usual and easy, as we may see in the case of the Vanderbilt property, that the divisive principle has full sway. Lastly, it needs no prophet to predict that the passion for immense wealth characterizing "great, intelligent, avaricious, sensual America," will decline. In its extreme form it is a passing characteristic of a transitional age; it is like the feverish and senseless desires of youth. Like the passion for power, which "the generality of mankind love so much more than liberty," it must decline when no longer necessary; and it will never again, probably, be so necessary as in the present generation. In so far as passion for power, or show, or wealth entails discomforts, it is bound to die out, unless there are compensating advantages; for they hamper their devotees in the race for survival.

How far we have reached in this great process is a much-mooted question. Numerous instructive facts are, however, before our very eyes. The fabulous amounts spent by the laboring classes for amusements, liquor, tobacco, and various things regarded as luxuries; the amount of money the labor organizations are able to handle; the vast increase in national wealth—out of all proportion to the increase in population—competing for the hire of labor; the great increase in savings-bank deposits and depositors; the proved increase in money-wages, and in the purchasing power of wages; the decrease, still going on under our very eyes, of the hours of labor; the reduced fluctuations in prices; the increased average length of life, recognized by insurance companies; the increased consumption of necessaries *per*

capita *—all these seem to point to the fact that great progress has already been made.

The general view here taken of our recent economic evolution may be stated in mechanical terms. Mr. Spencer's words are somewhat abstract and difficult to fully comprehend, as a great many eminent persons have found out; but they must here be quoted for the perfection with which they cover the case:

"In the second order" (of equilibrations), "comprehending the various kinds of vibration or oscillation as usually witnessed, the motion is used up in generating a tension which, having become equal to it, or momentarily equilibrated with it, thereupon produces a motion in the opposite direction, that is subsequently equilibrated in like manner, thus causing a visible rhythm, that is, however, soon lost in invisible rhythms." †

III. Having endeavored to view the phenomena of wealth-distribution from an evolutionary standpoint, let us now eliminate the element of time, and see if we may thus obtain additional light by altering our point of view. The question is, What is the most advantageous distribution of wealth at a given moment? In seeking a reply, the following considerations inevitably come before the mind:

1. "A more equal distribution of wealth tends *prima facie* to increase happiness"; ‡ since the amount of happiness given by wealth obviously increases, not directly as the wealth, but in a constantly decreasing ratio. But—

2. We have to allow for a decrease in the amount of wealth produced. This would result, first, from the increased idleness of large numbers engaged in productive employments. Probably there are persons that would deny that any such decrease would take place. A little observation of the advantage taken by the Indians of governmental interference with distribution in their favor would probably bring such persons a little nearer to the earth; especially if it were followed up by some study of the numerous ways in which most working-men get rid of their hard-won earnings. Another loss similar to the above would be through decreased saving. Increased idleness and increased non-productive expenditure, as for drink, amusements, etc., would lessen the total national capital. Still another loss would come through the lessened efficiency of capital in the management of enterprise—very much like the lessened efficiency of an army if each soldier were required to develop his views on the next movement of the campaign; for it must be assumed that interference with the ratios of distribution would tend to give the workmen power over the management of the capital. Here, again, there will very likely be

* See Mr. Giffin's admirable pamphlet, which has been much grumbled at by men who are eager to try their hands at remaking the world in a day, but whose figures and facts remain.

† "First Principles," p. 487.

‡ Sidgwick, p. 517, and after.

some denial, and a great many expressions of doubt; but it seems sufficient to say that, if the more democratic form of industry were at present practicable, it would not have failed so often as it has in picked cases. Lastly, not only would there be less wealth to distribute, but the number among whom it would be divided would, from known biological laws, be increased in a startling ratio; only afterward to diminish with the same excessive speed when the penalty for waste fell upon the world.*

It thus becomes plain that it is difficult, not to say impossible, to tell where a more equal distribution of wealth will be for the public advantage; and particularly *how* equal the distribution should be. It is a matter far too delicate for the wisest assembly that ever sat. Even if this were not the case, there should still be no interference with the natural ratios of distribution, and for this reason, which lies at the heart of all our remarks: *that the want of economic virtues in the mass is the exact measure of the advantage of the few.* The few can not surpass the many except as their superiority permits, and any limitation of the free action of the superior is therefore certain to result in public economic damage; and hence the best adaptation of the ratios of distribution is natural, and not artificial or legislative. The result of our special examination is a confirmation of our general examination.

We have still to deal with the question of inheritance. The acquisition of large properties in this way is in conflict with the first principle of a free industrial system, which in general requires each person to earn what he gets, excepting children and the infirm or aged. Here too, however, there are opposing considerations. In the first place, there is no way to prevent the transmission of property—if wills were made legally null, their office could be practically occupied in various ways. Even overlooking this obstacle, we are confronted with the damage resulting from the embargo on the natural activities and affections of men. The economic damage thus resulting would be inestimable. Again, the management of property acquires, by means of inheritance and bequest, a stability very necessary for the best results. And here, too, as in the former case, it is impossible to be sure that the spontaneous desires of men do not in the long run lead to the public advantage. Probably the sentiments governing this matter are as much the offspring of social discipline as the sentiments called moral. We find that customs of inheritance change from age to age and conform to the temper of the time. In an age like the present the first

* A certain increase of population has, as Mr. George says, the effect of increasing every man's share of the total production, through the increased division of labor allowed; but, obviously, that increase can outrun the capacity for profiting by it. If the entire population of China were landed in the United States at once, a great many—several hundred millions, probably—would starve before our industrial system could adapt itself to the vast increase of population.

object generally in the mind of a rich man, aside from the care of his family, is the welfare of the property bequeathed. In this respect the will of the late Mr. Vanderbilt was conspicuous. The measures taken to secure the united management of the great fortune left by him may be highly commended simply as a piece of public policy. It is not too much to say that, if, in consequence of a contrary policy, the New York Central or Vanderbilt system of roads had gone to pieces, the whole northern part of the United States would have suffered substantial injury.

A sentiment regarding the disposition of property at death, noticed by J. S. Mill as existing in America, still retains its hold; we mean the sentiment favoring the settlement of great sums on charities, churches, and especially on educational institutions. A California millionaire has recently set aside an immense fortune, said to amount to $20,000,000, for a university in that State. From an economic point of view there is absolutely no defense of such an action. It simply means the perpetual expenditure—the economic waste—of the whole annual yield of the property donated. Of course, the defense can be made that as property is for life, and not life for property, we should not regard wealth spent on things so necessary as education as misapplied. And if it be taken for granted that future ages will not know enough, or will not have the means to pay for the education needful for them, this is a good defense. But if, as we must here maintain, it be thought that the wants of a time are best met by the spontaneous agency of the time—as we see in the superiority of our popularly-sustained churches over state-supported establishments—then, from a social as well as from an economic standpoint, we must decide against the advisability of such great gifts. The possibility that our mania for education may lead to as much loss and inconvenience as the former mania which resulted in state religious establishments seems to be forgotten. Leaving all this aside, however, it should still be borne in mind that such a withdrawal of capital as that instanced is a distinct injury to trade and to the working classes; and further that any perpetuity is almost certain to become unresponsive to the needs of a new age, and is likely to become as useless as are, according to Professor Huxley, the great endowments which maintain fellowships at the English universities. Wherever the line between benevolent and reproductive expenditure should be drawn, it seems highly probable that the public sentiment in favor of public legacies is unduly strong, at least among those whose views find their way into print; and that the private sentiment which we see in daily operation is really much more beneficial to the country.

If the views taken in this article have any basis in truth, the opinions commonly held are to a large extent wrong in nearly every way connected with the present subject. Public opinion is, indeed, a vague and indefinite quantity. But we may fairly say that it opposes the

accumulation of large quantities of wealth in single hands; while such accumulation has not only been indispensable, as it still is, in developing our country, and an indispensable reward of enterprise, but, even leaving this out of account, is for the greatest good of the greatest number because it best preserves capital and employs labor most productively. We may say that public opinion favors interference with the natural ratios of distribution, as may be seen by usury laws, exemption laws, laws abridging freedom of contract, river and harbor bills, laws imposing heavy taxes on corporations, and so forth; while in general the natural ratios are the best for the public interest. Only the most immediate considerations are generally weighed; and unjust laws, like the Potter railroad law of Wisconsin, have to result in manifest public damage before they are repealed. It can hardly be doubted that before the late war, when the Jeffersonian maxims in regard to legislation still held sway, our political development was higher than it has been since; and the same may be said of our general ideas on public policy. But unceasing education in business methods of thinking are plainly forcing public opinion in the right direction, as was proved by the tone of the public press regarding the recent strike on the Missouri Pacific, and by the strong attacks lately made on the Blair education bill. Meanwhile there will be much of what might be called unnecessary blundering and suffering; but in reality this will be necessary to develop the needed habits and ideas.

METEORITES, METEORS, AND SHOOTING-STARS.*

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YOU are kindly giving to me an hour to-night in which I may speak to you. I do not have enough confidence in myself to justify me in speaking to such an audience as this upon one of those broad subjects that belong equally to all sections of the Association. The progress, the encouragements, and the difficulties in each field are best known to the workers in the field, and I should do you little good by trying to sum up and recount them. Let me rather err, then, if at all, by going to the opposite extreme.

Two years ago your distinguished president instructed and delighted us all by speaking of the pending problems of astronomy, what they are, and what hopes we have of solving them. To one subject in this one science, a subject so subordinate that he very properly gave it only brief notice, I ask your attention. I propose to state some propositions which we may believe to be probably true about the meteorites, the meteors, and the shooting-stars.

* Address of the retiring President of the American Association for the Advancement of Science, delivered at Buffalo, August 19, 1886.

In trying to interest you in this subject, so remote from the studies of most of you, I rely upon your sense of the unity of all science, and at the same time upon the strong hold which these weird bodies have ever had upon the imaginations of men. In ancient times temples were built over the meteorite images that fell down from Jupiter, and divine worship was paid them, and in these later days a meteorite stone that fell last year in India became the object of daily anointings and other ceremonial worship. In the fearful imagery of the Apocalypse the terrors are deepened by there falling "from heaven a great star burning as a torch," and by the stars of heaven falling "unto the earth as a fig-tree casteth her unripe figs when she is shaken of a great wind." The "great red dragon, having seven heads and ten horns, and upon his heads seven diadems" is presented in the form of a huge fire-ball. "His tail draweth the third part of the stars of heaven, and did cast them to the earth." Records of these feared visitors, under the name of flying dragons, are found all through the pages of the monkish chroniclers of the middle ages. The Chinese appointed officers to record the passage of meteors and comets, for they were thought to have somewhat to say to the weal or woe of rulers and people.

By gaining in these later days a sure place in science, these bodies have lost their terrors, but so much of our knowledge about them is fragmentary, and there is still so much that is mysterious, that men have loved to speculate about their origin, their functions, and their relations to other bodies in the solar system. It has been easy, and quite common, too, to make these bodies the cause of all kinds of things for which other causes could not be found.

They came from the moon; they came from the earth's volcanoes; they came from the sun; they came from Jupiter and the other planets; they came from the comets; they came from the nebulous mass from which the solar system has grown; they came from the fixed stars; they came from the depth of space. They supply the sun with his radiant energy; they give the moon her accelerated motion; they break in pieces heavenly bodies; they threw up the mountains on the moon; they made large gifts to our geologic strata; they cause the auroras; they give regular and irregular changes to our weather. A comparative geology has been built up from the relations of the earth's rocks to the meteorites; a large list of new animal forms has been named from their concretions; and the possible introduction of life to our planet has been credited to them. They are satellites of the earth; they travel in streams, and in groups, and in isolated orbits about the sun; they travel in groups and singly through stellar spaces; it is they that reflect the zodiacal light; they constitute the tails of comets; the solar corona is due to them; the long coronal rays are meteor-streams seen edgewise.

Nearly all of these ideas have been urged by men deservedly of

the highest repute for good personal work in adding to human knowledge. In presence of this host of speculations, it will not, I hope, be a useless waste of your time to inquire what we may reasonably believe to be probably true. And if I shall have no new hypotheses to give to you, I offer as my excuse that nearly all possible ones have been already put forth. This Association exists, it is true, for the advancement of science, but science may be advanced by rejecting bad hypotheses as well as by framing good ones. I begin with a few propositions about which there is now practical unanimity among men of science. Such propositions need only be stated. The numbers that are to be given express quantities that are open to revision and moderate changes:

1. The luminous meteor-tracks are in the upper part of the earth's atmosphere. Few, if any, appear at a height greater than one hundred miles, and few are seen below a height of thirty miles from the earth's surface, except in rare cases, when stones and irons fall to the ground. All these meteor-tracks are caused by bodies which come into the air from without.

2. The velocities of the meteors in the air are comparable with that of the earth in its orbit about the sun. It is not easy to determine the exact values of those velocities, yet they may be roughly stated as from fifty to two hundred and fifty times the velocity of sound in the air, or of a cannon-ball.

3. It is a necessary consequence of these velocities that the meteors move about the sun and not about the earth as the controlling body.

4. There are four comets relating to four periodic star-showers that have occurred on the dates of April 20th, August 10th, November 14th, and November 27th. The meteroids which have given us any one of these star-showers constitute a group, each individual of which moves in a path which is like that of the corresponding comet. The bodies are, however, now too far from one another to influence appreciably each other's motions.

5. The ordinary shooting-stars in their appearance and phenomena do not differ essentially from the individuals in star-showers.

6. The meteorites of different falls differ from one another in their chemical compositions, in their mineral forms, and in their tenacity. Yet through all these differences they have peculiar common properties which distinguish them entirely from all terrestrial rocks.

7. The most delicate researches have failed to detect any trace of organic life in meteorites.

These propositions have practically universal acceptance among scientific men. We go on to consider others which have been received with hesitation, or in some cases have been denied.

With a great degree of confidence we may believe that shooting-stars are solid bodies. As we see them they are discrete bodies, separated even in prolific star-showers by large distances one from another.

We see them penetrate the air many miles, that is, many hundred times their own diameters at the very least. They are sometimes seen to break in two. They are sometimes seen to glance in the air. There is good reason to believe that they glance before they become visible.

Now, these are not the phenomena which may be reasonably expected from a mass of gas. In the first place a spherical mass of matter at the earth's distance from the sun, under no constraint and having no expansive or cohesive power of its own, must exceed in density air at one sixth of a millimetre pressure (a density often obtained in the ordinary air-pump) or else the sun by his unequal attraction for its parts will scatter it. Can we conceive that a small mass of gas with no external constraint to resist its elastic force can maintain so great a density?

But suppose that such a mass does exist, and that its largest and smallest dimensions are not greatly unequal; and suppose further that it impinges upon the air with a planetary velocity; could we possibly have as the visible result a shooting-star? When a solid meteorite comes into the air with a like velocity, its surface is burned or melted away. Iron masses and many of the stones have had burned into them those wonderful pittings or cupules which are well imitated, as M. Daubrée has shown, by the erosion of the interior of steel cannon by the continuous use of powder under high pressure. They are imitated also by the action of dynamite upon masses of steel near which the dynamite explodes. Such tremendous resistance that mass of gas would have to meet. The first effect would be to flatten the mass, for it is elastic; the next to scatter it, for there is no cohesion. We ought to see a flash instead of a long burning streak of light. The mass that causes the shooting-star can hardly be conceived of except as a solid body.

Again, we may reasonably believe that the bodies that cause the shooting-stars, the large fire-balls, and the stone-producing meteor, all belong to one class. They differ in kind of material, in density, in size. But from the faintest shooting-star to the largest stone-meteor we pass by such small gradations that no clear dividing lines can separate them into classes. See wherein they are alike:

1. Each appears as a ball of fire traversing the apparent heavens just as a single solid but glowing or burning mass would do.

2. Each is seen in the same part of the atmosphere, and moves through its upper portion. The stones come to the ground, it is true, but the luminous portion of their paths generally ends high up in the air.

3. Each has a velocity which implies an orbit about the sun.

4. The members of each class have apparent motions which imply common relations to the horizon, to the ecliptic, and to the line of the earth's motion.

5. A cloudy train is sometimes left along the track, both of the stone-meteor and of the shooting-star.

6. They have like varieties of colors, though in the small meteors they are naturally less intense and are not so variously combined as in the large ones.

In short, if bodies that produce the various kinds of fire-balls had just the differences in size and material which we find in meteorites, all the difference in appearances would be explained, while, on the other hand, a part of the likenesses that characterize the flights points to something common in the astronomical relations of the bodies that produce them. This likeness of the several grades of luminous meteors has not been admitted by all scientific men. Especially was it not accepted by your late president, Professor J. Lawrence Smith, who by his studies added so much to our knowledge of the meteorites. The only objection, however, so far as I know, that has been urged against the relationship of the meteorites and the star-shower meteors, and the only objection which I have been able to conceive of that has apparent force, is the fact that no meteorites have been secured that are known to have come from the star-showers. This objection is plausible, and has been urged both by mineralogists and astronomers as a perfect reply to the argument for a common nature to all the meteors. But what is its real strength? There have been in the last one hundred years five or six star-showers of considerable intensity. The objection assumes that, if the bodies then seen were like other meteors, we should have reason to expect that among so many hundreds of millions of individual flights a large number of stones would have come to the ground and have been picked up.

Let us see how many such stones we ought to expect. A reasonable estimate of the total number of meteors in all of these five or six showers combined makes it about equal to the number of ordinary meteors which come into the air in six or eight months. Inasmuch as we can only guess at the numbers seen in some of the showers, let us suppose that the total number for all the star-showers was equal to one year's supply of ordinary meteors. Now, the average annual number of stone-meteors of known date from which we have secured specimens has during this hundred years been about two and a half.

Let us assume, then, that the luminous meteors are all of like origin and astronomical nature; and further assume that the proportion of large ones, and of those fitted to come entirely through the air without destruction, is the same among the star-shower meteors as among the other meteors. With these two assumptions, a hundred years of experience would then lead us to expect two or perhaps three stone-falls from which we secure specimens during all the half-dozen star-showers put together. To ask for more than two or three is to demand of star-shower meteors more than other meteors give us. The failure to get these two or three may have resulted from chance, or from some pecul-

iarity in the nature of the rocks of Biela's and Tempel's comets. It is very slender ground upon which to rest a denial of the common nature of objects that are so similar in appearance and behavior as the large and small meteors.

It may be assumed, then, as reasonable that the shooting-stars and the stone-meteors, together with all the intermediate forms of fire-balls, are like phenomena. What we know about the one may with due caution be used to teach facts about the other. From the mineral and physical nature of the different meteorites we may reason to the shooting-stars, and from facts established about the shooting-stars we may infer something about the origin and history of the meteorites. Thus it is reasonable to suppose that the shooting-stars are made up of such matter and such varieties of matter as are found in meteorites. On the other hand, since star-showers are surely related to comets, it is reasonable to look for some relation of the meteorites to the astronomical bodies and systems of which the comets form a part.

This common nature of the stone-meteor and the shooting-stars enables us to get some idea, indefinite but yet of great value, about the masses of the shooting-stars. Few meteoric stones weigh more than one hundred pounds. The most productive stone-falls have furnished only a few hundred pounds each, though the irons are larger. Allowing for fragments not found, and for portions scattered in the air, such meteors may be regarded as weighing a ton, or it may be several tons, on entering the air. The explosion of such a meteor is heard a hundred miles around, shaking the air and the houses over the whole region like an earthquake. The size and brilliancy of the flame of the ordinary shooting-star are so much less than those of the stone-meteor that it is reasonable to regard the ordinary meteoroid as weighing pounds, or even ounces, rather than tons.

Determinations of mass have been made by measuring the light and computing the energy needed to produce the light. These are to be regarded as lower limits of size, because a large part of the energy of the meteors is changed into heat and motion of the air. The smaller meteors visible to the naked eye may be thought of without serious error as being of the size of gravel-stones, allowing, however, not a little latitude to the meaning of the indefinite word gravel. These facts about the masses of shooting-stars have important consequences.

The meteors, in the first place, are not the fuel of the sun. We can measure and compute within certain limits of error the radiant energy emitted by the sun. The meteoroids large enough to give shooting-stars visible to the naked eye are scattered very irregularly through the space which the earth traverses, but in the mean each is distant two or three hundred miles from its near neighbors. If these meteoroids supply the sun's radiant energy, a simple computation shows that the average shooting-star ought to have a mass enormously greater than is obtained from the most prolific stone-fall. Moreover, if

these meteoroids are the source of the solar heat, their direct effect upon the earth's heat by their impact upon our atmosphere ought also to be very great; whereas the November star-showers, in some of which a month's supply of meteoroids was received in a few hours, do not appear to have been followed by noticeable increase of heat in the air.

Again, the meteoroids do not cause the acceleration of the moon's mean motion. In various ways the meteors do shorten the month as measured by the day. By falling on the earth and on the moon they increase the masses of both, and so make the moon move faster. They check the moon's motion, and so bringing it nearer to the earth shorten the month. They load the earth with matter which has no momentum of rotation, and so lengthen the day. The amount of matter that must fall upon the earth in order to produce in all these ways the observed acceleration of the moon's motion has been computed by Professor Oppolzer. But his result would require for each meteoroid an enormous mass, one far too great to be accepted as possible. Again, the supposed power of such small bodies, bodies so scattered as these are even in the densest streams, to break up the comets or other heavenly bodies, and also their power by intercepting the sun's rays to affect our weather, must in the absence of direct proof to the contrary be regarded as insignificant.

So, too, their effect in producing geologic changes by adding to the earth's strata, has without doubt been very much over-estimated. During a million of years, at the present rate of say fifteen millions of meteors per day, there comes into the air about one shooting-star or meteor for each square foot of the earth's surface. To assume a sufficient abundance of meteors in ages past to accomplish any of these purposes is, to say the least, to reason from hypothetical and not from known causes. The same may be said of the suggestion that the mountains of the moon are due to the impact of meteorites. Enormously large meteoroids in ages past must be arbitrarily assumed, and, in addition, a very peculiar plastic condition of the lunar substance in order that the impact of a meteoroid can make in the moon depressions ten, or fifty, or a hundred miles in diameter, surrounded by abrupt mountain-walls, two and three and four miles high, and yet the mountain-walls not sink down again.

The known visible meteors are not large enough nor numerous enough to do the various kinds of work which I have named. May we not assume that an enormous number of exceedingly small meteoroids are floating in space, are falling into the sun, are coming into our air, are swept up by the moon? May we not assume that some of these various forms of work, which can not be done by meteoroids large enough for us to see them as they enter the air, are done by this finer impalpable cosmic dust? Yes, we make such an assumption. There exist, no doubt, multitudes of these minute particles traveling

in space. But science asks not only for a true cause, but a sufficient cause. There must be enough of this matter to do the work assigned to it. At present we have no evidence that the total existing quantity of such fine material is very large. It is to be hoped that through the collection and examination of meteoric dust we must soon learn something about the amount which our earth receives. Until that shall be learned, we can reason only in general terms. So much matter coming into our atmosphere as these several hypotheses require would without doubt make its presence known to us in the appearance of our sunset skies, and in a far greater deposit of meteoric dust than has ever yet been proved.

A meteoroid origin has been assigned to the light of the solar corona. It is not unreasonable to suppose that the amount of the meteoroid matter should increase toward the sun, and the illumination of such matter would be much greater near the solar surface. But it is difficult to explain upon such an hypothesis the radical structure, the rifts, and the shape of the curved lines that are marked features of the corona. These seem to be inconsistent with any conceivable arrangement of meteoroids in the vicinity of the sun. If the meteoroids are arranged at random, there should be a uniform shading away of light as we go from the sun. If the meteoroids are in streams along cometary orbits, all lines bounding the light and shade in the coronal light should evidently be approximately projections of conic sections, of which the sun's center is the focus. There are curved lines in abundance in coronal light, but as figured by observers and in the photographs they seem to be entirely unlike any projections of conic sections. Only by a violent treatment of the observations can the curves be made to represent such projections. They look more as though they were due to forces at the sun's surface than at its center. If those complicated lines have any meteoroid origin (which seems very unlikely) they suggest rather the phenomena of comets' tails than meteoroid streams or sporadic meteors. The hypothesis that the long rays of light which sometimes have been seen to extend several degrees from the sun at the time of the solar eclipse are meteor-streams seen edgewise seems possibly true but not at all probable.

The observed life of the meteor is only a second, or at most a few seconds, except when a large one sends down stones to remain with us. What can we learn about its history and origin? Near the beginning of this century, when small meteors were looked on as some form of electricity, the meteorites were very generally regarded as having been thrown out from the lunar volcanoes. But as the conviction gained place that the meteorites moved not about the earth but about the sun, it was seen that the lunar volcanoes must have been very active to have sent out such an enormous number of stones as are needed in order that we should so frequently encounter them. When it was further considered that there is no proof that lunar volcanoes are now

active, and that when they were active they were more likely to have been open seas of lava, not well fitted to shoot out such masses, the idea of the lunar origin of the meteorites gradually lost ground. But the unity of meteorites with shooting-stars, if true, increases a hundred-fold the difficulty, and would require that the comets have the same origin with the meteorites. No one claims that the comets came from the moon.

That the meteorites came from the earth's volcanoes is still maintained by some men of science, particularly by the distinguished astronomer royal for Ireland. The difficulties of the hypothesis are, however, exceedingly great. In the first place, the meteorites are not like terrestrial rocks. Some minerals in them are like minerals in our rocks. Some irons are like the Greenland terrestrial irons. But no rock in the earth has been yet found that would be mistaken for a meteorite of any one of the two or three hundred known stone-falls. The meteorites resemble the deep terrestrial rocks in some particulars, it is true, but the two are also thoroughly unlike. The terrestrial volcanoes must also have been wonderfully active to have sent out such a multitude of meteorites as will explain the number of stone-falls which we know and which we have good reason to believe have occurred. The volcanoes must also have been wonderfully potent. The meteorites come to us with planetary velocities. In traversing the thin upper air they are burned and broken by the resisting medium. Long before they have gone through the tenth part of the atmosphere, the meteorites usually are arrested and fall to the ground. If these bodies are sent out from the earth's volcanoes, they left the upper air with the same velocity with which they now return to it. This the law of gravitation demands. What energy must have been given to the meteorite before it left the volcano to make it traverse the whole of our atmosphere and go away from the earth with a planetary velocity! Is it reasonable to believe that volcanoes were ever so potent, or that the meteorites would have survived such a journey?

No one claims that the meteors of the star-showers, nor that their accompanying comets, came from the earth's volcanoes. To ascribe a terrestrial origin to meteorites is, then, to deny the relationship of the shooting-star and the stone-meteor. Every reason for their likeness is an argument against the terrestrial origin of the stones.

To suppose that meteors came from any planets that have atmospheres involves difficulties not unlike to and equally serious with those of a terrestrial origin. The solar origin of meteorites has been seriously urged and deserves a serious answer. The first difficulty which this hypothesis meets is that solid bodies should come from the hot sun. Besides this, they must have passed without destruction through an atmosphere of immense thickness, and must have left the sun with an immense velocity. Then there is a geometric difficulty. The meteorite shot out from the sun would travel under the law of gravitation

nearly in a straight line out and back again into the sun. If in its course it enters the earth's atmosphere, its relative motion, that which we see, should be in a line parallel to the ecliptic, except as slightly modified by the earth's attraction. A large number of these meteors —that is most, if not all, well-observed fire-balls—have certainly not traveled in such paths. These did not come from the sun.

It has been a favorite hypothesis that the meteorites came from some planet broken in pieces by an internal catastrophe. There is much which mineralogists can say in favor of such a view. The studies of M. Stanislas Meunier and others into the structure of meteorites have brought out many facts which make their hypothesis plausible. It requires, however, that the stone-meteor be not regarded as of the same nature as the star-shower meteor, for no one now seriously claims that the comets are fragments of a broken planet. The hypothesis of the existence of such a planet is itself arbitrary ; and it is not easy to understand how any mass that has become collected by the action of gravity and of other known forces should by internal forces be broken in pieces and these pieces rent asunder. The disruption of such a planet by internal forces, after it has by cooling lost largely its original energy, would be specially difficult to explain.

We can not then look to the moon nor to the earth, nor to the sun, nor to any of the large planets, nor to a broken planet, as the first home of the meteoroids, without seeing serious if not insuperable objections. But since some of the meteoroids were in time past certainly connected with comets, and since we can draw no line separating shooting-stars from stone-meteors, it is most natural to assume that all of them are of a cometary origin. Are there any insuperable objections that have been urged against the hypothesis that all of the meteoroids are of like nature with the comets, that they are in fact fragments of comets, or it may be in some cases minute comets themselves?

If such objections exist, they ought evidently to come mainly from the mineralogists, and from what they find in the internal structure of the meteorites. Astronomy has not as yet furnished any objections. It seems strange that comets break in pieces, but astronomers admit it, for it is an observed fact. It is strange that groups of these small bodies should run before and follow after comets along their paths ; but astronomers admit it is a fact in the case of at least four comets. Astronomically there would seem to be no more difficulty in giving such origin to the sporadic meteor, and to the large fire-ball, and to the stone-meteor, than there is in giving it to the meteor of the star-shower. If, then, the cometic origin of meteorites is inadmissible, the objections must come mainly from the nature and structure of the meteoric stones and irons. Can the comet in its life and history furnish the varied conditions and forces necessary to the manufacture or growth of these peculiar structures? It is not necessary, in order to answer this question, to solve the thousand puzzling problems that

can be raised about the origin and behavior of comets. Comets exist in our system, and have their own peculiar development, whatever be our theories about them. It will be enough for my present purpose to assume as probably true the usual hypothesis that they were first condensed from nebulous matter; that that matter may have been either the outer portions of the original solar nebula, or matter entirely independent of our system and scattered through space.

In either case the comet is generally supposed, and probably must be supposed, to have become aggregated far away from the sun. This aggregation was not into one large body to be afterward broken up by disruption or by solar action. The varieties of location of the cometic orbits seem inexplicable upon any such hypothesis. Separate centers of condensation are to be supposed, but they are not *a priori* unreasonable. This is the rule rather than the exception everywhere in Nature. Assume, then, such a separate original condensation of the comet in the cold of space, and that the comet had a very small mass compared with the mass of the planets. Add to this the comet's subsequent known history as we are seeing it in the heavens. Have we therein known forces and changes and conditions of such intensity and variety as the internal structure of the meteorites calls for?

What that structure is, and to some extent what conditions must have existed at the time and place of its first formation, and during its subsequent transformations, mineralogists rather than astronomers must tell us. For a long time it was accepted without hesitation that these bodies required great heat for their first consolidation. Their resemblance to the earth's volcanic rocks was insisted on by mineralogists. Professor J. Lawrence Smith, in 1855, asserted, without reserve, that "they have all been subject to a more or less prolonged igneous action corresponding to that of terrestrial volcanoes." Director Haidinger, in 1861, said, "With our present knowledge of natural laws, these characteristically crystalline formations could not possibly have come into existence except under the action of high temperature combined with powerful pressure."

The likeness of these stones to the deeper igneous rocks of the earth, as shown by the experiments of M. Daubrée, strengthened this conviction. Mr. Sorby, in 1877, said: "It appears to me that the conditions under which meteorites were formed must have been such that the temperature was high enough to fuse stony masses into glass; the particles could exist independently one of the other in an incandescent atmosphere subject to violent mechanical disturbances; that the force of gravitation was great enough to collect these fine particles together into solid masses, and that these were in such a situation that they could be metamorphosed, further broken up into fragments, and again collected together."

Now, if meteorites could come into being only in a heated place, then the body in which they were formed ought, it would seem, to

have been a large one. But the comets, on the contrary, appear to have become aggregated in small masses. The idea that heat was essential to the production of these minerals was at first a natural one. All other known rock formations are the result of processes that involved water, or fire, or metamorphism. All agree that the meteorites could not have been formed in the presence of water or free oxygen. What conclusion was more reasonable than that heat was present in the form of volcanic or of metamorphic action?

The more recent investigations of the meteorites and kindred stones, especially the discussions of the Greenland native irons and the rocks in which they were imbedded, are leading mineralogists, if I am not mistaken, to modify their views. Great heat at the first consolidation of the meteoric matter is not considered so essential. In a late paper M. Daubrée says: "It is extremely remarkable that, in spite of their great tendency to a perfectly distinct crystallization, the silicate combinations which make up the meteorites are there only in the condition of very small crystals all jumbled together as if they had not passed through fusion. If we may look for something analogous about us, we should say that instead of calling to mind the long needles of ice which liquid water forms as it freezes, the fine-grained texture of meteorites resembles rather that of hoar-frost and that of snow, which is due, as is known, to the immediate passage of the atmospheric vapor of water into the solid state." So Dr. Reusch, from the examination of the Scandinavian meteorites, concludes that "there is no need to assume volcanic and other processes taking place upon a large heavenly body formerly existing, but which has since gone to pieces."

The meteorites resemble the lavas and slags on the earth. These lavas and slags are formed in the absence of water, and with a limited supply of oxygen, and heat is present in the process. But is heat necessary for the making of the meteorites? Some crystallizations do take place in the cold; some are direct changes from gaseous to solid forms. We can not in the laboratory reproduce all the conditions of crystallization in the cold of space. We can not easily determine whether the mere absence of oxygen will not account fully for the slag-like character of the meteorite minerals. Wherever crystallization can take place at all, if there are present silicon and magnesium, and iron and nickel, with a limited supply of oxygen, there silicates ought to be expected in abundance, and the iron and nickel in their metallic form. Except for the heat, the process should be analogous to that of the reduction of iron in the Bessemer cupola, where the limited supply of oxygen combines with the carbon and leaves the iron free. The smallness of the comets should not, then, be an objection to considering the meteoric stones and irons as pieces of comets. There is no necessity for assuming that they were parts of a large mass in order to provide an intensely heated birthplace.

But, although great heat was not needed at the first formation, there

are many facts about these stones which imply that violent forces have in some way acted during the meteorite's history. The brecciated appearance of many specimens; the fact that the fragments in a breccia are themselves a finer breccia; the fractures, infiltrations, and apparent faultings seen in microscopic sections, and by the naked eye—these all imply the action of force. M. Daubrée supposes that the union of oxygen and silicon furnishes sufficient heat for making these materials. If this is possible, those transformations may have taken place in their first home. Dr. Reusch argues that the repeated heating and cooling of the comet as it comes down to the sun and goes back again into the cold, is enough to account for all the peculiarities of structure of the meteorites. These two modes of action do not, however, exclude each other.

Suppose, then, a mass containing silicon, magnesium, iron, nickel, a limited supply of oxygen, and small quantities of other elements, all in their primordial or nebulous state (whatever that may be), segregated somewhere in the cold of space. As the materials consolidate or crystallize, the oxygen is appropriated by the silicon and magnesium, and the iron and nickel are deposited in metallic form. Possibly the heat developed may, before it is radiated into space, modify and transform the substance. The final result is a rocky mass (or possibly several adjacent masses) which, sooner or later, is no doubt cooled down throughout to the temperature of space. This mass in its travels comes near to the sun; powerful action is there exerted upon it. It is heated. How intense is that heat upon a cold rock unprotected apparently by its thin atmosphere it is not possible to say. We know that the sun's action is strong enough to develop and drive off into space that immense train, the comet's tail, that sometimes spans our heavens. It is broken in pieces. We have seen the portions go away from the sun, to come back probably as separate comets. Solid fragments are scattered from it, to travel in their own independent orbits.

What is the condition of the burned and crackled surface of a cometic mass or fragment as it goes out from the sun again into the cold? What changes and recrystallizations may not that surface undergo before it comes back again to pass anew through the fiery ordeal? We have here forces that we know are acting. They are intense, and act under varied conditions. The stones subject to those forces can have a history full of all the scenes and actions required for growth of such strange bodies as these that come down to us. Some of our meteors, those of the star-showers, certainly had that history. What good reason is there for saying that all of them may not have had the like birthplace and life?

Before I close, let me add one lesson that has been taught us by recent star-showers. The pieces which come into our air in any recurring star-shower belong to a group whose shape is only partly known. It is thin, for we traverse it in a short time. It is not a uniform ring,

for it is not annual, except possibly in the case of the August sprinkle. How the sun's unequal attraction for the part of a group acts as a dispersive force to draw it out into a stream, those most beautiful and most fruitful discussions of Signor Schiaparelli have shown. The groups that we meet are certainly in the shape of thin streams.

It has been assumed that the cometic fragments go continuously away from the parent mass so as to form in due time a ring-like stream of varying density, but stretched along the entire elliptic orbit of the comet. The epochs of the Leonid star-showers in November, which have been coming at intervals of thirty-three years since the year 902, have led us to believe that this departure of the fragments from Tempel's comet (1866, 1) and the formation of the ring were very slow processes. The meteors which we met near 1866 were therefore thought to have left the comet many thousands of years ago. The extension of the group was presumed to go on until at some time in the future, perhaps tens of thousands of years hence, the earth was to meet the stream every year.

Whatever may be the case with Tempel's comet and its meteors, this slow development is not found to be true for the fragments of Biela's comet. It is quite certain that the meteors of the splendid displays of 1872 and 1885 left the immediate vicinity of that comet later than 1840, although at the time of those showers they had become separated two hundred millions of miles from the computed place of the comet. The process, then, has been an exceedingly rapid one, requiring, if continued at the same rate, only a small part of a millennium for the completion of an entire ring, if a ring is to be the finished form of the group.

It may be thought reasonable, in view of this fact about Biela's comet, established by the star-showers of 1872 and 1885, to revise our conception of the process of disintegration of Tempel's comet also. The more brilliant star-showers from this comet have always occurred very near the end of the thirty-three-year period. Instead of there being a slow progress which is ultimately to produce a ring along the orbit of the comet, it certainly seems more reasonable to suppose that the compact lines of meteors which we met in 1866, 1867, and 1868, left the comet at a recent date. A thousand years ago this shower occurred in the midle of October. By the precession of the equinoxes and the action of the planets the shower has moved to the middle of November. One half of this motion is due to the precession of the equinoxes, the other half to the perturbing action of the planets. Did the planets act upon the comet before the meteoroids left it ; or upon the meteoroid stream ? Until one has reduced the forces to numerical values, he may not give to this question a positive answer. But I strongly suspect that computations of the forces will show that the perturbations of Jupiter and Saturn upon the group of meteoroids hundreds of millions of miles in length—perturbations strong enough to change the node of

the orbit fifteen degrees along the ecliptic—would not leave the group such a compact train as we found it in 1866. If this result is at all possible, it is because the total action is scattered over so many centuries. But it seems more probable that the fragments are parting more rapidly from the comet than we have assumed, and that long before the complete ring is formed the groups become so scattered that we do not recognize them, or else are turned away so as not to cross the earth's orbit.

Comets by their strange behavior and wondrous trains have given to timid and superstitious men more apprehensions than have any other heavenly bodies. They have been the occasion of an immense amount of vague and wild and worthless speculation by men who knew a very little science. They have furnished a hundred as yet unanswered problems which have puzzled the wisest. A world without water, with a strange and variable envelope which takes the place of an atmosphere, a world that travels repeatedly out into the cold and back to the sun, and slowly goes to pieces in the repeated process, has conditions so strange to our experience, and so impossible to reproduce by experiment, that our physics can not as yet explain it. Yet we may confidently look forward to the answer of many of these problems in the future. Of those strange bodies, the comets, we shall have far greater means of study than of any other bodies in the heavens. The comets alone give us specimens to handle and analyze. Comets may be studied, like the planets, by the use of the telescope, the polariscope, and the spectroscope. The utmost refinements of physical astronomy may be applied to both. But the cometary worlds will be also compelled, through those meteorite fragments with their included gases and peculiar minerals, to give up some additional secrets of their own life and of the physics of space to the blow-pipe, the microscope, the test-tube, and the crucible.

SOME OUTLINES FROM THE HISTORY OF EDUCATION.

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II.

We may define history as the narration of events in their causal relations. Nowhere does this definition find more instructive application than in the evolution of education. We see here, and with unmistakable plainness, the effect of distinctive contributions from the sides of our common nature. The stages in the history of education are *natural* growths ; each movement in the unfolding was a necessity. Our present paper will consider many facts which, by themselves, would appear so unnatural, so out of relation to modern

thought and feeling, that we could but gaze upon them in wonder. Not one of these manifestations, however, but is rooted in the inborn constitution of our fellows. To recognize this is to sympathize with the past—that is, to understand it, wherein also, and wherein alone, we realize the present. The history of education from the early Christian centuries throughout the middle-age period is the expression of a one-sided development starting from a misunderstood Christianity. The new religion was contra-natural, contra-earthly; its training was for heaven. Though some may claim that this teaching did not lie fairly in the authoritative records of the Church, there was much in these records to favor it, and much more still in the situation of the first Christians. Persecution would force attention from things temporal to things eternal. The present would be but a trial, a testing. This misinterpretation was laid upon the early Christians even as it seems to be laid upon many unfortunate souls to-day. Those for whom life is a ceaseless curse need such power as may well be said to come from on high to place the blame where it belongs, on broken law and wasted opportunity. The gospel of a heaven on earth, of a heaven in and by law, of a heaven in and by the present right life, is not even now fully come, though we give thanks for its presence here and there.

My former paper called attention to the following points: the early relations of Christian education with heathen education, the gradual extension of Christianity and the shaping of all instruction for a religious life, Arabian culture, the character of middle-age education as unnatural, contra-earthly. We shall now look directly at this middle-age training. Where did the teachers of the middle ages teach? In the cloister schools, the cathedral schools, and the parochial schools. These parochial or common schools never amounted to much, because the masses of the people had little interest in knowledge. Still, at a comparatively early time the popes established the parochial schools by the side of the parish church. Charlemagne ordered that the children should be instructed in reading, singing, reckoning, some grammar and writing; and a council held at Mainz, before the middle of the ninth century, required that the children should be sent either to the cloister schools or to those of the parish, that they might learn the Creed and the Lord's Prayer in their own language. The cloister schools are classed as those of the Benedictines, Dominicans, and Franciscans. The first Benedictine monastery was founded at Monte Casino, in the kingdom of Naples, about 529, by St. Benedict himself. This order increased so wonderfully and became so powerful that it may be said to have been the chief means for the spread of learning throughout the West from the sixth to the twelfth century. At first the regulations of St. Benedict were for those only who had set themselves apart to the service of the Church. But, with the increase of the reputation of the order, it

became necessary to provide instruction for those scholars who were not devoting themselves to the monkish life. In keeping with this demand, the cloister schools were established : there were also so-called nunneries of this order, the first at Bischofsheim, in France, being widely celebrated. These cloister schools for girls did the work of elementary schools, and concerned themselves especially with household duties. The supreme importance of this Benedictine order ceased in the twelfth century. Then the Dominicans and Franciscans took up the work, and, though they did not accomplish so much as the other orders, their results were marked in providing better school-books. They taught mostly the Lord's Prayer, church melodies, and Latin.

A word as to the origin of the cathedral schools. While the Benedictine order was becoming powerful, the parochial schools suffered greatly from the ignorance and incapacity of the parish priests. This disturbed Chrodegang (Bishop of Metz, 742) so greatly that he took the priests who were connected with his own cathedral and bound them together in a cloister-like seclusion for the instruction of the youth according to the Benedictine rules. Their life was ordered by strictest regulations, their duties were accurately written down for them, and their chief instruction consisted of the Holy Scriptures and song. The life in these cathedral schools was a modified monkish life—the good work they did for education is justly said to be this, that they made it freer, bringing it out of the cloisters and more into general view.

What did the young people study in the middle-age schools? First and most essential was religion ; after that, the following : grammar, rhetoric, and dialectic ; music, arithmetic, geometry, and astronomy. The first three of these were called the *trivium* (as suggested, probably, because in Rome it was customary to give elementary instruction in some public place where three or more roads came together). The four other studies were called the *quadrivium*. In North Africa the trivium and quadrivium came together for the first time and formed what was known as the seven liberal arts ; seven, being a sacred number, gave great value to this circle of study. Any one making the least pretension to education must pass through the trivium ; the quadrivium was for those who had finished the first course and desired further training.

We inquire as to the meaning of these seven studies of the middle ages :

Grammar.—This consisted of instruction in the Latin language. First, the scholar learned to pronounce, then he mastered the quantity of the syllables, the forms of the declensions and conjugations ; then he took up some productions of the easier Latin writers ; and, finally, went on to the more difficult prose authors and poets. After this, he learned accent, the number of feet in the verse, analogy, etymology, and foreign words. Then the Latin author was explained critically ;

every verse was taken to pieces and looked at grammatically, meterically, and historically. (They had rules for the position of the mouth in pronunciation.) Greek was, after some time, introduced into the Western schools and taught in the same general manner as the Latin. Hebrew was seldom an object of study. The modern languages were not taught.

Dialectic.—This represented philosophy in general. In the lower schools it was a mere collection of phrases. The boy learned the categories, the moods and figures of the syllogism and practiced definitions and disputations. There was a partial translation of Plato's "Timæus," which prevailed to the thirteenth century. In the higher schools, especially from the tenth to the twelfth century, religion was taught in connection with philosophy, and this latter study was in every way made to defend the faith.

Rhetoric.—This was taught, at first, according to Quintilian and Cicero; later the text-books of Capella and Bede took their place; in the tenth century Quintilian became again the leader. The rules of rhetoric were applied to sermon-writing, and the first treatise on this subject was composed about the year 1300.

Music.—This study received special attention. Ambrose of Milan originated the church songs, and Charlemagne summoned teachers of song from Rome, and laid great stress upon musical training. Instruction in this department was based upon the text-books of Boëthius, and the notes were marked by the letters of the alphabet until Benedict of Pomposa and Guido of Arezzo (1030) introduced the system of lines. The marking of the notes according to their continuance and length was devised in the fourteenth century by Johns of Myris, while before this the higher and lower notes were expressed by ascending and lowering lines.

Arithmetic.—This was next to music in importance as an object of study. To express numbers the hands and feet were used. The left hand upon the breast signified 10,000 and both hands 100,000. In business and housekeeping accounts a reckoning-board was used. This was a table upon which upright parallel lines were cut, that represented values of units, tens, hundreds, etc. These lines were filled with stones to express numbers: thus, for 4,576 we should have on the first line at the right, six stones, then seven, and so on.

Geometry.—This was taught in the higher and lower schools after selections from Euclid. Lines, figures, and solids were defined, and chief examples of them given. There was generally associated with this study a kind of geography, and it is said that the cloister of St. Gallen had a map as early as the seventh century.

Astronomy.—This study, which had been pursued long before among the Greeks, and which was a principal concern with the Arabians, received no attention in the Western Church until Charlemagne had some correspondence with Rabanus respecting it. The schools

used an Englishman's book, called the Book of the Spheres. As is well known, astronomy was very closely bound up with astrology, of which there was a professorship in the University of Bologna. In the lower schools all instruction in astronomy was confined to the reckoning of the Easter feasts and the Church calendar.

We have thus outlined the principal objects of pursuit during the middle ages. History had no place in the course of study. Jurisprudence, as it came from Rome, did receive, in some places, special attention from the priestly orders. At York it took the place of dialectic and was studied for the cultivation of the judgment. Physics and chemistry were pursued secretly, if at all, and the former degenerated into magic, the latter into alchemy.

Possibly this review of the middle-age studies may have obscured the leading idea with which we started, and by which the entire period is characterized—that is, the idea of religion.

The following words from a leader in middle-age education will show the grasp of the Church upon all the training of the time :

"Grammar discloses the art of explaining the old poets and writers ; at the same time it gives ability to read and write without mistake. By grammar alone we understand the figures and unaccustomed modes of speech of the Sacred Scriptures and seize the true meaning of the divine words.

"Prosody, also, one should not neglect, because in the Psalms there are many kinds of verses ; for this reason the fluent reading of heathen poets and frequent practice in poetry are not to be disregarded. But the old poets must first be very carefully purified, that nothing remain in them which has reference to love and love ceremonies, or to the heathen deities. Rhetoric, which gives the different classes and chief parts of speech, together with the accompanying rules, is important for such young persons only as have nothing more serious to attend to, and it must be learned only out of the holy fathers. Dialectic, on the other hand, is the queen of all the arts and sciences. In her dwells reason. Philosophy alone can furnish knowledge and wisdom ; she alone declares what and whence we are, she alone teaches us our destination, through her alone we learn to know the good and the evil. How necessary she is for the priestly man, that he may contend with and overcome the unbeliever ! Arithmetic is important because of the secrets which are contained in numbers, and Scripture requires arithmetic to be learned, in that the Holy Word speaks of numbers and measures. Geometry is necessary because, in Scripture, at the building of Noah's Ark and Solomon's Temple, circles of all kinds appear.

"Music and astronomy are necessary for divine service, which, without music, could not be conducted worthily and impressively, and without astronomy could not be held on set and appointed days."

We have now, in our outline, reached that period to which history gives the name Reformation. Up to this time, young men were study-

ing their trivium and quadrivium in the cloister schools and cathedral schools. Scholastic philosophy had turned the activities of reason into unqualified support of the doctrines of religion. "New things seem now to take place upon the face of the earth. Copernicus discovers the sun-system, Columbus beholds another side of this great world, Magellan marks out the true form of the earth, Bacon applies his intellect to the formation of science." As we thus abruptly state these things, and as we consider their immense influence upon later history, it seems as though they came like new creations, suddenly thrust in upon the world's life, disconnected with all that preceded them, having no natural causes in the antecedent ages. It is the delightful task of history to present a *development*, to show the connections, be they ever so hidden, between the changing phenomena of human life. We may rest assured that not one among these startling events which make up the Reformation era is without its natural causes in the preceding times. Our task, however, is to follow education amid the changes that are taking place. Since religion was at the bottom of everything when the middle ages were closing, it follows, necessarily, that any radical reformation would appear first of all and most powerfully in religion. We know that the conflict which Luther brought to the daylight was a religious conflict, and we also realize that education could not be reached except through religion, as this was the supreme power controlling all the activities of men. Let us say, then, that the Church was divided into Catholic and Protestant. How was education affected by this division? Not so remarkably or beneficially as many would have expected. Luther, and those who worked with him, understood the power of education and wrote much upon the subject, yet they could not establish education rightly, and for a very plain reason. They needed help from the schools, they needed a training for their special teachings. The time was a time for self-defense. Therefore, after the Reformation had well set in, and after the reformers had established schools of all grades for their own children, we see no change in education except that it was made to support the Protestant religion in addition to the older faith. It was religion still with which education was vitally connected, and the reformers made no advance beyond the old scholastic system. When, therefore, we look at education after the Reformation was a fact, we find it still in the complete control of religion. We see two churches instead of one, and all the development or change that education could experience must be in the line of these church organizations.

In the Catholic Church education passed under the control of that wonderful order, the Jesuits. The Society of Jesus was a reformation within the Catholic Church, and the order exercised enormous influence. It reached directly into school and family, and made its teachings profoundly felt. These schools of the Jesuits taught, in addition to the ancient languages, mathematics, history, natural phi-

losophy, and paid special attention to good conduct and bodily exercise. The instruction was conducted by most perfect mechanism, the memory was inordinately developed, and obedience absolute. This system served the Church; and no better scholars, according to this standard, could be found than those who came from the institutes of the Jesuits.

The first condition for education is freedom—a freedom limited by nothing except the individual conscience and the rights of our fellow-men. Therefore any educational system established solely for the benefit of a special party or creed can have value for those persons only who, of choice, belong to the party, and of choice accept the creed. We have seen that middle-age training was exclusively a contra-earthly training. We have seen, also, that education was not allowed the necessary freedom by the reformers. Their liberty of conscience, as all know, was but slavery compared with the later and fuller realization. Our present point of outlook is the wide-spread attention given to the subject of education. The thing to be done is to sever education from its constrained, unnatural relation to the Church. During the last years of Luther's life (1546), this work was commenced by the two Germans Trotzendorf and Sturm. Most noticeable here is the unconsciousness of these men as to the significance of their undertaking. John Sturm was born at Schleiden in 1507. In 1537 he came to Strasburg, organized the gymnasium here, and remained as its rector from 1538 to 1583. It is said that the schools established by Sturm and under the direction of his teachers numbered many thousand students, among them pupils from Portugal, Poland, and England.

The central thing in all right education was, according to Sturm, the Latin language. Unlike Melanchthon, he wished Latin to be studied for *its own sake*, not for the Church. "He would secure for the German youth the same culture which distinguished the youths of Greece and Rome." Education is passing from the control of the Church to the control of Greece and Rome. This exchange was an advantage, though it was by no means the liberty which maketh free indeed. For centuries boys were to study Greek and Latin *nolens volens*, up, down, and all around. Here is the origin, the natural origin, of that supremacy of the classics in education which, inevitable and serviceable for many years, seeks in vain to maintain itself forever. We shall appreciate Sturm's system best by looking at the plan of his schools, which, fortunately, has been preserved.

"For the first seven years the mother shall bring up the child. At the seventh year the boy is brought to school. The school-training lasts nine years. Then begins the freer method, such as hearing lectures and practicing disputations. Of the nine classes which the scholar must pass through in nine years, seven classes and seven years are set apart for the mastery of the extra pure Latin speech, two

classes and two years to the acquisition of elegancies. Subsequently a tenth class was added; in this lowest class the basis was laid. Here the children learned the form and pronunciation of the letters, then reading, which can be better gained by Latin declensions and conjugations than by the catechism. In the ninth class the pupils were perfected in declension and conjugation, and grappled with the irregular verbs. At the same time a multitude of Latin words representing common objects were learned, and each pupil daily received a number of special words to be committed to memory. In the eighth class the first thing to be considered was that the boy forgot nothing of what he had learned in the preceding classes. Those who entered this class must be able to parse all leading words and adverbs. This they learned more through practice than in any scientific manner, as the Roman and Greek boys exercised themselves in speech before the grammar was given them. In this eighth class the separate declensions and conjugations were distinguished and marked by examples which the scholars could take from the words already learned. Then Cicero's letters were to be translated with sole reference to the grammar. Some practice in style appears for the first time during the last months of the year; there were oral exercises in the formation of new Latin phrases, and the transposition of those already assigned.

"The seventh class takes special care that nothing is forgotten; then Latin syntax is dealt with in simple rules—these rules are explained by Ciceronian examples. Each day Cicero's letters are read, for in this class they must read much in order to gain much. The themes for practice in style are selected from that which the pupil has learned in this or the preceding classes, thus making these themes a refreshment of the memory. The teacher must help his pupils orally and by writing on the blackboard. On Sunday the German catechism is translated into classical Latin.

"Since the preservation of what is learned is no less an art than learning anew, the sixth class must not forget anything. Longer letters of Cicero are now translated into German, and different letters are given to companies of ten. In like manner various poetical pieces are assigned to different pupils; the Andria of Terence and the first poetical volume are read. In connection with writing, the pupils are compelled to pay special attention to the minute development of their style. Saturday evenings and Sundays they continue translation of the catechism; some letters of Jerome are read, and Greek is commenced. From the fifth class onward the scholars are made acquainted with the less-known words and their objects. Metrical composition is studied, and in the later months of the year this is joined with some practical exercises. Then mythology is taken up; Cicero's Lælius and Virgil's Eclogues are read. In Greek the pupils learn to name the virtues and vices and habits of men; they write them down carefully in their dictionary. Style must be further de-

veloped, and at the same time something oratorical is read, which has been retranslated into Latin. Saturday evenings and Sundays the shorter letters of Paul are studied.

"In the fourth class the scholar hears as much as possible, interprets, memorizes, and recites, but nothing that goes beyond his power. Select letters and compositions from Horace are read, then everything learned in the preceding classes is repeated. Saturday evenings and Sundays the pupil himself gives simple paraphrased explanations of Paul's letters. In the third class they retain what has been learned and enlarge upon it. The ornaments of rhetoricians, such as tropes and figures, are explained and illustrated. In Greek the better orations of Demosthenes are read, then the first book of the Iliad, followed by exercises in style. Some parts of the Greek orations are translated into Latin, or the Latin into Greek. The odes of Pindar and Horace are set to other metre; many poems are made and many letters written. The comedies of Plautus and Terence are brought out, and the boys compete with the higher classes. In the second class the boys are obliged to interpret Latin and Greek orators literally, so that the teacher simply calls attention to the relation of the oratorical and political usage, and requires the pupils to enter in their day-books all remarkable portions of the author. The same thing is done with the Latin writers, and these are compared with the Greek. Dialectic, the instrument of the truth, is now put into the pupil's hands; at first only the critical part, later the figurative, then rhetoric, which must always be at the side of the scholar. The Olynthiac and Philippic orations of Demosthenes are read in their bearing upon rhetoric, and the pupils are allowed to make their own selections. There are daily style exercises, and with them some short declamations which are written down by the scholars and then learned *verbatim.* On Sunday the Epistle to the Romans is read and learned, and repeated *verbatim* by all. The first class continues rhetoric and dialectic. The citation of dialectic and rhetorical rules must be proved out of Demosthenes and Cicero. Homer and Virgil are read further, and Thucydides is translated into writing; no week passes without providing some plays. The Epistles of Paul are explained by the pupils, and selected portions are enlarged upon according to rhetorical rules."

These schools of Sturm contained no history, no geography, no natural history, no physics, no elementary instruction in the German language. Arithmetic was taught only in the second class; some few sentences from the first book of Euclid and the elements of astronomy were learned in the first class. The motto was Ciceronian Latin. The problem was to turn a boy into an automatic Latin machine, capable of clicking out Ciceronian sentences. Education approximated ideal perfection in proportion as it reproduced the Latin speech. Sturm, doing education great service, did it also serious harm. Ciceronian Latin—

this was the phrase that, like a curse, blighted the harmonious development of thousands of youth; the phrase that has carried over into our times such excessive zeal for the classics as has materially assisted to produce the present reaction. In saying this, we pronounce no opinion for or against the continuance of classical training in the college course of study. What may be said on that subject in these papers will appear elsewhere; our present purpose is to show historically the natural, necessary origin of that supremacy of Greek and Latin which many would maintain at all hazard.

The reformers did a great work, both directly and indirectly, for education. They failed to the extent that their idea of man was faulty. They did not understand the liberty which they proclaimed, yet they caused to be brought to light a most important problem, viz., the separation of religion, as dogma, from education—a separation which must take place before there can be any true union. Here was the indirect influence of the Reformation; its direct bearing upon education is found in the fact that this subject now became special matter for thought and endeavor. The Jesuits and the Lutherans systematized education as thoroughly as could be done in the interests of a dogmatic theology. We have seen the beginnings of the reaction. The schools of Sturm taught Latin and Greek for Latin and Greek's sake—not for Church or party. Here was the first step, right, indeed, for its time; a most serious misstep, however, for the remote future. A way had been opened for thought; and where thought begins there will be change; where thought continues there will be progress. Now men are directly at work to improve the methods of education. We have reached the time of individual and conscious effort.

We are concerned rather with general movements than with men, and for this reason shall refer to leading educators only so far as may be necessary to illustrate the evolution of our subject. Wolfgang Ratich was born at Wilster, in Holstein, October 18, 1571. In Holland he determined to appear as a reformer of the entire method of teaching the languages. His estimation of himself and what he could accomplish was altogether incredible: "I will give to my Fatherland and to all Christendom a remarkable service, and I will bestow upon them a most inexpressible advantage. Inside of eight or ten days I will disclose, in a strictly confidential manner, my method of languages. I will make known what amount in every language can be scientifically taught, learned, and spread abroad in one half year, as well by the old as the young, as well by women as children; and this, too, completely not piece-wise." Ratich was, as these words show, very much of a charlatan; still, he gained the attention of many influential men—among them Prince Ludwig and the Duke of Saxe-Weimar—and extraordinary efforts were made to reform the schools and methods of instruction. We need not dwell upon the miserable failure of this

undertaking, as far as respects any established instruction. The school, which was opened June 21, 1619, received the censure of the school inspectors on July 28th of the same year, and in October the reformer was cast into prison. Among the ideas generally accredited to Ratich as his own, the following are significant: "Education is a common, thorough-going work, and no one is to be shut out from it; every one must, at least, be capable of reading and writing. The young may be instructed in only one language or study at the same time; before this has been learned, they may not take up another. Everything must proceed according to the order of Nature, who, in all her arrangements, is wont to advance from the simpler and lower to the larger and higher. All subjects must be proceeded with in a twofold manner: first, they must be seized in outline or abbreviation; afterward, they should be comprehended and taught with more complete instruction." This brief account of Ratich furnishes clear evidence that attention was now given to education in remarkable degree. It shows the presence of new and true principles in the educational question, as witness the last quotations. Further, this account strikingly confirms our statements in the first paper, where the distinction was drawn between a scientific treatment of education and an enunciation of educational principles.

We now, and for the first time, meet an avowed attempt to treat education *philosophically*—that is, to apply ideas concerning man's nature to his education. This attempt was made by John Amos Comenius, born at Comnia, in Moravia, 1592. Comenius was every way great-minded, and had it thoroughly in him to teach. All philosophy has been and will continue to be distinguished by two fundamentally opposed methods. For our present purpose, we may characterize these methods by the terms intuitive and experimental. According to the first method, man, in his spiritual nature, contains the truth—*is* the truth. The idea, the reason, is alone permanent and real. According to the second method, man is dependent on an external world for the origin, continuance, and verification of *all* his knowledge. As related through the senses to nature, man is capable of reasoning and of correcting his conclusions. He brings no knowledge with him into the world. He is a power, or series of powers, to be awakened through the senses. It was the mission of Comenius to apply this inductive, experimental method to education.

For him, therefore, there was but one procedure in education, viz., *development of the natural capacities.* Education was an unfolding, not of original *knowledge* but of original *powers*, and this by such means as the senses furnished. A moment's reflection shows that his method directly antagonizes middle-age, Lutheran, and Calvinistic orthodoxy. The point of antagonism is the doctrine of man's condition as produced by the fall. Original sin had made man through and through bad, good for—*nothing;* how, then, could any educa-

tional system which proceeded upon no other plan than the development of man's capacities be other than false, disastrous, condemnable? Comenius saw clearly this opposition between his fundamental principle and orthodoxy, and endeavored to meet the difficulty by saying that man's fall did not utterly destroy his original powers, but weakened them, leaving it possible to secure a beneficial development. This reconciliation was no reconciliation, and the fault lay in the nature of the case, not in Comenius; all adjustment between these opposing views is impossible.

The words of Comenius, respecting the education of woman, are of special significance, and this alike from their time and their character. He said: "There is no reason why woman should be excluded from culture, either from that which comes through the Latin language or through the native tongue. Women also are images of the Godhead, and possess spiritual receptivity and capacity for training, often more than we—they too are often summoned to great work. Why should we let them come to the alphabet and then cast them away from books? Do we fear superficiality? But, the more thoughts a person gains, the less room is there for superficiality which always comes from spiritual emptiness." When we ask how Comenius dealt with education, we are to remember that he proceeded according to a philosophy of the matter. He had something to say about man before giving rules for his training. He consciously adopted that principle which we have affirmed to be essential, viz., that the idea man has of himself must determine his education. Comenius had an idea of man, and made it the guiding principle in his system. Man, so he maintained, lives a threefold life, a vegetative, an animal, and a rational or spiritual life. He has a threefold home—the mother, the earth, the heaven. By birth he enters his second home, by death and resurrection his third and eternal home. In the first we receive simply life with its movements and senses, in the second we gain life and the senses with rationality, in the third we reach the fulfillment of all things. That first life is a preparation for the second, the second a preparation for the third, the third is without end. Compare this understanding of man with the middle-age teaching. Here man is incarcerated in a body and dungeoned on the earth; for Comenius, man is provided with an organism and placed at school for the unfolding of his nature in an endless progress. According to the one view, man is to cast away his body as a thing accursed; according to the other, he is to use it as an instrument unto life.

Careful study of the writings of Comenius can not fail to impress one with the *naturalness*, that is, the *truth* of his method. From beginning to end his thought is an attempt to follow Nature, and this not after the impossible manner of Rousseau's "Émile," but by a patient scrutiny of natural processes everywhere appearing. Man is one with Nature, and, as so, Nature will show him how to educate himself—not,

will educate him—a distinction that requires full emphasis. In illustration of what has here been said, I translate a few passages from the works of Comenius:

"The *order* of instruction must be learned from Nature. Hence it follows that education has, first of all, to set forth and keep firm hold of the fundamental principles for the *preservation of life*, that the necessary time may be given to a course of instruction. We must guard the body from disease and deadly accident, because it is the only temporal residence of the soul, and because it *is the instrument of the rational spirit.* (Italics are the present writer's.)

"Nature waits, in all her undertakings, for the suitable time. So must we seize the right time for the discipline of the mind, and must *carry out this discipline progressively.* Training should begin in childhood, the spring-time of life; it should be prosecuted in the morning hours, the spring-time of the day; and that only should be learned *which is adapted to the capacity of apprehension.*" This simple sentence, had it been able to prevail from the time at which it was written, would have prevented the blank horror on many a youthful countenance as it faced the statement that "a noun and participle are put into the ablative called absolute to denote the time, cause, manner, means, the concomitant of an action, or the condition on which it depends."

To return to Comenius: "Nature first prepares the material, then gives it a form. The architect follows the same principle: he brings together all that is necessary for the building, and then works his material. Corresponding to this, we must have at hand in the schools all needful books and every appliance. *We must cultivate the understanding before the languages. We must teach no language from grammar but from its writers, and we must allow the experimental sciences to precede the organic.*

"Nature begins every one of her works from within. The bird proceeds from within outward. The tree draws its nourishment through the pores of the inner part; it grows from within. Likewise in education this requirement stands fast: *first help to gain an insight into the things, then cultivate the memory.*

"Nature begins all her works with the most universal and ends with the particular. When she builds a bird, she draws through the warmed mass a film, that an outline of the entire bird may arise. Then *and for the first time* she shapes each particular portion. The architect imitates this method. First he makes the tracing, then lays the foundation. The painter does the same. He does not at first paint a complete ear, but makes an outline of the countenance and then paints it in. Accordingly, the youth who give themselves to study must, *in the very first part* of their training, lay the groundwork of a *universal culture.* The objects of pursuit must be so ordered that the later studies will not appear to bring anything new, but sim-

ply the development of that which has been given into its distinguishing features. Every language, science, and art, must begin with the most simple rudiments, in order that the idea of the whole may arise; *then* follow the *rules*.

"Nature makes no leap, but advances step by step. The bird first tries her wings on the nest, after that from branch to branch, later from tree to tree, at last freely through the air. Corresponding to this the studies must be brought into an order, that the earlier may serve as introductions to the later, may mark out a pathway. The one who is to be instructed *must see himself learn*. Therefore everything should be conducted according to its immovable principles. *Nothing should be taught on simple authority; everything must be subjected to the test of the senses and the proof of reason.* It is a golden rule of life—represent everything to the senses; that which can be seen to the sight, that which can be heard to the hearing, and that which can be felt to the touch. The beginning of knowledge necessarily proceeds from the senses. The truth and certainty of knowledge depend upon the testimony of the senses. Eye-sight stands for proof."

Any reflection upon these words of Comenius makes it clear that his system proceeds from a sound view of human nature and of the task of education. The philosophical ideas originated elsewhere, as in England and France, were applied by Comenius to education. He did this work in no servile way, but fearlessly and well.

It is possible that we are in danger of drawing wrong conclusions with respect to the amount and extent of improvement thus far actually effected in education. Considering only the true principles set forth by the reformers Ratich and Comenius, and remembering also how frequently these men were summoned to amend the school systems, we might naturally conclude that the work was done; we might believe that education had been rescued from its paralysis in the Church and its mechanism under Sturm. Nothing, however, could be more wide of the mark than such a conclusion. The law of progress is here a little and there a little. Though Sturm and Ratich and Comenius and Bacon and Montaigne and Locke had spoken and spoken truth, the truth prevailed not; could not prevail until there was added to its simple articulation in language the irresistible force of events; until scientific discovery, pervading and bettering society, made men heed the manner and course of Nature.

We need to hold clearly in mind the exact work to be done. It was to secure for man as man a freedom for development limited by nothing save an enlightened conscience and the rights of his fellows. Representative men had begun this work. The masses of the people, however, went on their way as of old, and another unlooked-for step was to be taken before the right path appeared.

THE MICROBES OF ANIMAL DISEASES.*

By E. L. TROUESSART.

THE first of the virulent and contagious diseases in which the presence of a microbe was positively ascertained was anthrax, or splenic fever, which attacks most of our horned animals, and especially cattle and sheep.

As early as 1850, Davaine had observed the presence of minute rods in the blood of animals which died of splenic fever; but it was only in 1863, after Pasteur's first researches into the part played by microbes in fermentations, that Davaine suspected these rods of being the actual cause of the disease. He inoculated healthy animals with the tainted blood, and thus ascertained that even a very minute dose would produce a fatal attack of the disease, and the rods, to which he gave the name of *Bacteridia*, could always be discovered in enormous numbers in the blood.

The microbe so named by Davaine must from its characteristics be assigned to the genus Bacillus, and is now termed *Bacillus anthracis*. This disease, which affects men as well as animals, is characterized by general depression, by redness and congestion of the eyes, by short

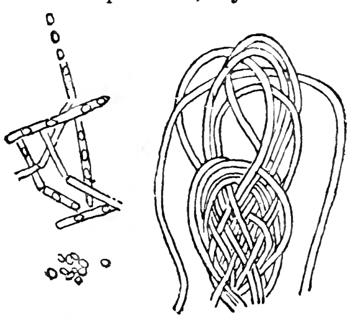

FIG. 1.—*Bacillus anthracis* of splenic fever in different stages of development; bacilli, spores, and curled filaments (much enlarged).

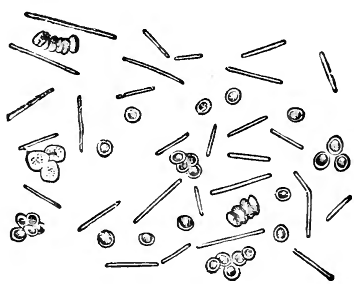

FIG. 2—*Bacillus anthracis*, produced in Guinea-pig by inoculation; corpuscles of blood and bacilli.

and irregular respiration, and by the formation of abscesses, which feature, in the case of the human subject, has procured for it the name of malignant pustule. The disease is quickly terminated by death, and an autopsy shows that the blood is black, that intestinal hæmorrhage has occurred, and that the spleen is abnormally large, heavy, and gorged with blood; hence the name of splenic fever. The disease is generally inoculated by the bite of flies which have settled upon carcasses and absorbed the bacteria, or by blood-poisoning through some accidental scratch, and this is especially the case with

* From "Microbes, Ferments, and Molds." By E. L. Trouessart. Vol. lvi, "International Scientific Series." New York: D. Appleton & Co. 1886.

knackers and butchers who break and handle the bones of animals which have died of anthrax.

The period of incubation is very short. An ox which has been at work may return to the stall apparently healthy. He eats as usual; then lies down on his side and breathes heavily, while the eyes are still clear. Suddenly his head drops, his body grows cold; at the end of an hour the eye becomes glazed; the animal struggles to get up, and falls dead. In this case, the illness has only lasted for an hour and a half (Empis).

In order to prove that the disease is really caused by *Bacillus anthracis*, Pasteur inserted a very small drop of blood, taken from an animal which had recently died of anthrax, in a glass flask which contained an infusion of yeast, neutralized by potassium and previously sterilized. In twenty-four hours the liquid, which had been clear, was seen to be full of very light flakes, produced by masses of bacilli, readily discernible under the microscope. A drop from the first flask produced the same effect in a second, and from that to a third, and so on. By this means the organism was completely freed from all which was foreign to it in the original blood, since it is calculated that, after from eight to ten of such processes, the drop of blood was diluted in a volume of liquid greater than the volume of the earth. Yet the tenth, twentieth, and even the fiftieth infusion would, when a drop was inserted under the skin of a sheep, procure its death by splenic fever, with the same symptoms as those produced by the original drop of blood. The bacillus is, therefore, the sole cause of the disease.

These cultures have often since been repeated by numerous observers, so that the microbe has been studied in all its forms, and the extent of its polymorphism has been ascertained. At the end of two days the bacterium, which, while still in the blood, is of a short abrupt form, displays excessively long filaments, which are sometimes rolled up like a coil of string. In about a week many of the filaments contain refracting, somewhat elongated nuclei. These nuclei presently form chaplets, in consequence of the rupture of the cell-wall of the rod which gave birth to them; others, again, float in the liquid in the form of isolated globules. These nuclei are the spores or germs of the microbes, which germinate when placed in the infusion, become elongated, and reproduce fresh bacilli.

These spores are much more tenacious of life than the microbes themselves. The latter perish in a temperature of 60°, by desiccation, in a vacuum, in carbonic acid, alcohol, and compressed oxygen. The spores, on the other hand, resist desiccation, so that they can float in the air in the form of dust. They also resist a temperature of from 90° to 95°, and the effects of a vacuum, of carbonic acid, of alcohol, and compressed oxygen.

In 1873 Pasteur, aided by Chamberland and Roux, carried on some experiments on a farm near Chartres, in order to discover why this dis-

ease is so common in some districts, in which its spread can not be ascribed to the bite of flies. Grass, on which the germs of bacteridia had been placed, was given to the sheep. A certain number of them died of splenic fever. The glands and tissues of the back of the throat were very much swelled, as if the inoculation had occurred in the upper part of the alimentary canal, and by means of slight wounds on the surface of the mucous membrane of the mouth. In order to verify the fact, the grass given to the sheep was mixed with thistles and bearded ears of wheat and barley, or other prickly matter, and in consequence the mortality was sensibly increased.

In cases of spontaneous disease it was surmised that the germs which were artificially introduced into food in the course of these experiments are found upon the grass, especially in the neighborhood of places in which infected animals had been buried. It was, in fact, ascertained that these germs existed above and around the infected carcasses, and that they were absent at a certain distance from their burial-place. It is true that putrid fermentation destroys most of the bacteria, but before this occurs a certain number of microbes are dispersed by the gas disengaged from the carcass ; these dry up and produce germs, which retain their vitality in the soil for a long while.

The mechanism by means of which these germs are brought to the surface of the soil and on to the grass on which the sheep feed is at once simple and remarkable. Earth-worms prefer soils which are rich in humus or decomposing organic substance, and seek their food round the carcass. They swallow the earth containing the germs of which we have spoken, which they deposit on the surface of the soil, after it has traversed their intestinal canals, in the little heaps with which we are all acquainted. The germs do not lose their virulence in their passage through the worms' intestines, and, if the sheep swallow them together with the grass on which they browse, they may contract the disease. The turning-up of the soil by the spade or plow may produce the same effect.

A certain warmth is necessary for the formation of germs ; none are produced when it falls below 12°, and the carcasses buried in winter are therefore less dangerous than those buried in the spring and summer. It is, in fact, in hot weather that the disease is most prevalent. Animals may, however, contract it even in their stalls from eating dry fodder on which germs of these bacteria remain.

Pasteur and his pupils performed an experiment in the Jura in 1879, which clearly shows that the presence of germs above the trenches in which carcasses have been buried is the principal cause of inoculation. Twenty oxen or cows had perished, and several of them were buried in trenches in a meadow where the presence of these germs was ascertained. Three of the graves were surrounded by a fence, within which four sheep were placed. Other sheep were folded within a few yards of the former, but in places where no infected animals had been buried.

At the end of three days three of the sheep folded above the graves had died of splenic fever, while those excluded from them continued to be healthy. This result speaks for itself.

Malignant pustule, which is simply splenic fever, affects shepherds, butchers, and tanners, who handle the flesh and hide of tainted animals. Inoculation with the bacillus almost always occurs in consequence of a wound or scratch on the hands or face. In Germany, fatal cases of anthrax have been observed, in which the disease has been introduced through the mouth or lungs, as in the case of the sheep observed by Pasteur. The human subject appears, however, to be less apt to contract the disease than herbivora, since the flesh of animals affected by splenic fever, and only killed when the microbe is fully developed in the blood, is often eaten in farm-houses. In this case the custom prevalent among French peasants of eating overcooked meat constitutes the chief safeguard, since the bacteria and their germs are thus destroyed.

The rapidity with which anthrax is propagated by inoculation generally renders all kinds of treatment useless: if, however, the wound through which the microbe is introduced can be discovered, it should be cauterized at once. This method is often successful in man. The pustule is cauterized with red-hot iron, or with bichloride of mercury and thymic acid, two powerful antiseptics, certain to destroy the bacteridium. It is expedient, as a hygienic measure, to burn the tainted carcasses, and, if this is not done, they should be buried at a much greater depth than is usually the case.

But the preservative means on which chief reliance is now placed is vaccination with the virus of anthrax. Pasteur has ascertained that when animals are inoculated with a liquid containing bacteridia of which the virulence has been attenuated by culture carried as far as the tenth generation, or even further, their lives are preserved. They take the disease, but generally in a very mild form, and it is an important result of this treatment that they are henceforward safe from a fresh attack of the disease; in a word, they are *vaccinated* against anthrax.

In the cultures prepared with the view of attenuating the microbe, it is the action of the oxygen of the air which renders the bacteridium less virulent. It should be subjected to a temperature of from 42° to 43° in the case of *Bacillus anthracis*, to enable it to multiply, and at the same time to check the production of spores which might make the liquid too powerful. At the end of the week, the culture, which at first killed the whole of ten sheep, killed only four or five out of ten. In ten or twelve days it ceased to kill any; the disease was perfectly mild, as in the case of the human vaccinia. After the bacteridia have been attenuated, they can be cultivated in the lower temperature of from 30° to 35°, and only produce spores of the same attenuated strength as the filaments which form them (Chamberland).

The vaccine thus obtained in Pasteur's laboratory is now distributed throughout the world, and has already saved numerous flocks from almost certain destruction. Although this process has only been known for a few years, its results are such that the gain to agriculture already amounts to many thousands of pounds.

Toussaint makes use of a slightly different mode of preparing a vaccine virus, which is, however, analogous to that of Pasteur. He subjects the lymph of the blood of a diseased animal to a temperature of 50°, and thus transforms it into vaccine. Toussaint considers the high temperature to be the principal agent of attenuation, and ascribes little or no importance to the action of the oxygen in the air.

Chamberland and Roux have recently made researches with the object of obtaining a similar vaccine by attenuating the primitive virus by means of antiseptic substances. They have ascertained that a solution of carbolic acid of one part in six hundred destroys the microbes of anthrax, while they can live and flourish in a solution of one part in nine hundred, but without producing spores, and their virulence is attenuated. When a nourishing broth is added to a solution of one in six hundred, the microbe can live and grow in it for months. Since the chief condition of attenuation consists in the absence of spores, this condition seems to be realized by the culture in a solution of carbolic acid, one in nine hundred, and it is probable that a fresh form of attenuated virus may thus be obtained. Diluted sulphuric acid gives analogous results. However this may be, the vaccine prepared by Pasteur's process is the only one which has been largely used, and which has afforded certain results to cattle-breeders.

Public experiments, performed before commissions composed of most competent men, have clearly shown the virtue of the protective action. In the summer of 1881 the initiation was taken by the Melun Society of Agriculture. Twenty-five sheep and eight cows or oxen were vaccinated at Pouilly-le-Fort, and then reinoculated with blood from animals which had recently died of anthrax, together with twenty-five sheep and five cows which had not been previously vaccinated. None of the vaccinated animals suffered, while the twenty-five test sheep died within forty-eight hours, and the five cows were so ill that the veterinary surgeons despaired of them for several days.

This experiment was publicly repeated in September, 1881, by Thuillier, Pasteur's fellow-worker, whose death we have recently had to deplore, before the representatives of the Austro-Hungarian Government; and again near Berlin, in 1882, before the representatives of the German Government, and always with the same success. Up to April, 1882, more than one hundred and thirty thousand sheep and two thousand oxen or cows had been vaccinated; and since that time the demand for vaccine from Pasteur's laboratory has reached him from every quarter.

The sickness of barn-door poultry, which is commonly called cholera, is caused by the presence in the blood of a small micrococus or bacterium in the form of the figure 8, differing, therefore, in form from *Bacillus anthracis*, but also an aërobie. It may be cultivated in chicken-broth, neutralized by potash, while it soon dies in the extract of yeast, which is so well adapted to *Bacillus anthracis*. The microbe of this disease may also be attenuated by culture, and it may be done more easily than in the case of anthrax, since it is not necessary to raise the temperature, as the bacterium of fowl-cholera does not produce spores under culture. Pasteur has therefore been able to prepare an attenuated virus well adapted to protect fowls from further attacks of this disease.

The disease affecting swine, which is called *rouget*, or swine-fever, in the south of France, has been recently studied by Detmers in the United States, where it is also very prevalent, and by Pasteur in the department of Vaucluse. It is a kind of *pneumo-enteritis*. These observers consider that the disease is caused by a very slender microbe, formed, like that of fowl-cholera, in the shape of the figure 8, but more minute. Others say that there is a bacillus which was observed by Klein as early as 1878 in swine attacked by this disease. In spite of the apparent contradiction, it is probable that we have only two forms of the same microbe, for the bacillus in Klein's culture at first

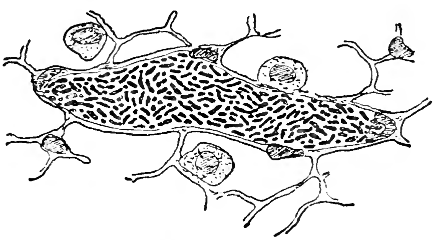

Fig. 3.—Swine Fever: section of a lymphatic gland, showing a blood-vessel filled with microbes (much enlarged). (Klein.)

resembles *Bacterium termo*, in the form of an 8, before it is elongated into rods. Pasteur has succeeded in making cultures of microbes in the figure 8. He has inoculated swine with the attenuated form, after which they have been able to resist the disease, so there is reason to hope that in the near future this new vaccine, containing the attenuated microbe, may become the safeguard of our pig-sties.

An epidemic which raged in Paris in 1881 was called the typhoid fever of horses, and was fatal to more than fifteen hundred animals belonging to the General Omnibus Company in that city. This disease is also produced by a microbe, with which Pasteur was able to inoculate other animals (rabbits); for this purpose he made use of the serous discharge from the horses' nostrils. The inoculated rabbits died with all the symptoms and lesions characteristic of the disease. The attenuation of this microbe by culture is difficult, since at the end of a

certain time the action of the air kills it. Pasteur has, however, found an expedient by which to accomplish his purpose. When the culture is shown to be sterile in consequence of the death of the microbe, he takes as the mother-culture of a fresh series of daily cultures the one which was made on the day preceding the death of the first mother-culture. In this way he has obtained an attenuated virus with which to inoculate rabbits, and the same result might undoubtedly be obtained in the case of horses.

There are many other contagious diseases which affect domestic animals, and which are probably due to microbes, such as, for instance, the infectious pneumonia of horned cattle. This was probably the first disease in which the protective effects of inoculation were tried, according to Wilhelm's method. This method consisted in making an incision under the animal's tail with a scalpel dipped in the purulent mucus or blood taken from the lung of a beast which had died of pneumonia; sometimes the serous discharge from the swelling under the tail of an inoculated animal was used for others. Fever and loss of appetite ensued, lasting from eight to twenty-five days, but the animal was afterward safe from further attacks of the disease. Cattle-plague, or contagious typhus, is likewise ascribed to the presence of a microbe with which we are as yet imperfectly acquainted.

Experimental septicæmia is entitled to special mention, since it has too often been confounded with anthrax, and has been unskillfully produced with the intention of vaccinating animals in accordance with Pasteur's process. This occurs when too long an interval (twenty-four hours) elapses after the death of an animal, before taking from it the blood intended for vaccine cultures. After this date the blood no longer contains *Bacillus anthracis*, which is succeeded by another microbe termed *Vibrio septicus*, differing widely from the anthrax microbe in form, habit, and character (Fig. 4). *Bacillus anthracis* is straight and immobile, while the septic vibrio is sinuous, curled, and mobile. Moreover, it is anaërobic, and does not survive contact with the air, but it thrives in a vacuum or in carbonic acid. Since *Bacillus anthracis* is, on the other hand, an aërobie, it is clear that the two microbes can not exist simultaneously in the blood or in the same culture-liquid. The inoculation with this fresh microbe is no less fatal; its action is even more rapid than that of *Bacillus anthracis*, but the lesions are not the same; the spleen remains normal, while the liver is discolored. The septic vibrio is only found in minute quantities in the blood, so that it has escaped the notice of many observers. It is, however, found in immense numbers in the muscles, in the serous fluid of the intestines,

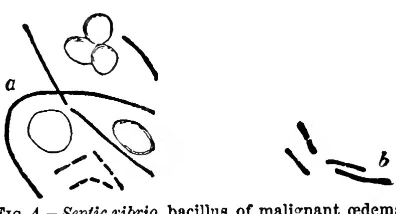

FIG. 4.—*Septic vibrio*, bacillus of malignant œdema (Koch): *a*, taken from spleen of Guinea-pig; *b*, from a mouse's lung.

and of other organs. It is very common in the intestines, and is probably the beginning of putrefaction.

Rabies is a canine disease which is communicated by a bite, and the inoculation of man and other animals by the saliva. We are not yet precisely acquainted with the microbe which causes the disease, but Pasteur's recent researches have thrown considerable light on its life-history, which is still, however, too much involved in obscurity. It must first be observed that the hypothetical microbe of rabies, which no one has yet discovered, should not be confounded with the microbe of human saliva; this is found in the mouths of healthy persons.

The following conclusions are the result of Pasteur's researches into the virus of rabies.

This virus is found in the saliva of animals and men affected by rabies, associated with various microbes. Inoculation with the saliva may produce death in three forms: by the salivary microbe, by the excessive development of pus, and finally by rabies. The brain, and especially the medulla oblongata, of men and animals which have died of rabies, is always virulent until putrefaction has set in. So also is the spinal cord. The virus is, therefore, essentially localized in the nervous system. Rabies is rapidly and certainly developed by trephining the bones of the cranium, and then inoculating the surface of the brain with the blood or saliva of a rabid animal. In this way there is a suppression of the long incubation which ensues from simple inoculation of the blood by a bite or intravenous injection on any part of the body. It is probable that in this case the spinal cord is the first to be affected by the virus introduced into the blood; it then fastens on its tissues and multiplies in them.

As a general rule, a first attack which has not proved fatal is no protection against a fresh attack. In 1881, however, a dog, which had displayed the first symptoms of the disease of which the other animals associated with him had died, not only recovered, but failed to take rabies by trephining, when reinoculated in 1882. Pasteur is now in possession of four dogs which are absolutely secured from infection, whatever be the mode of inoculation and the intensity of the virus. All the other test-dogs which were inoculated at the same time died of rabies. In 1884, Pasteur found the means of attenuating the virus. For this purpose he has inoculated a morsel of the brain of a mad dog into a rabbit's brain, and has passed the virus proceeding from the rabbit through the organism of a monkey, whence it becomes attenuated and a protective vaccine for dogs. This is the first step toward the extinction of this terrible disease.

Glanders, again, is a disease easily transmitted from horses to man. Glanders, or farcy, is caused by the presence of a bacterium, observed as early as 1868 by Christot and Kiener, and more recently studied at Berlin by Schütz and Löfler. This microbe appears in the form of very fine rods (*bacillus*) in the lungs, liver, spleen, and nasal cavity.

Babès and Havas found this bacillus in the human subject in 1881. Experimental cultures have been made simultaneously in France and Germany, and have given identical results.

Bouchard, Capitan and Charrin made their cultures in neutralized solutions of extract of meat, maintained at a temperature of 37°. By means of successive sowings, they have obtained the production of unmixed microbes, presenting no trace of the original liquid, and this was done in vessels protected from air-germs. These cultures may be carried to the eighth generation. Asses and horses inoculated with liquid containing the microbes produced by this culture have died with the lesions characteristic of glanders (glanderous tubercles in the spleen, lungs, etc.). Cats and other animals which have been inoculated in the same way die with glanderous tubercles in the lymphatic glands and other organs.

It follows from these experiments that the microbe which causes this disease is always reproduced in the different culture-liquids with its characteristic form and dimensions; that uni-ungulates can be inoculated with it, as well as man and other animals. In fact, this microbe is the essential cause of the disease.

We have already spoken of muscardine, a silk-worm's disease produced by a microscopic fungus; two other diseases are caused by distinct microbes, of which we must shortly speak. In the silk-worm nurseries, in which this disease prevails, the silk-worms which issue from the eggs, technically called seed, are slowly and irregularly developed, so as to vary greatly in size. Many die young, and those which survive the fourth molt shrink and shrivel away; they can hardly creep on to the heather to spin their cocoon, and produce scarcely any silk.

On an examination of the worms which have died of this disease, De Quatrefages ascertained the presence of minute stains on the skin and in the interior of the body, which he compared to a sprinkling of black pepper; hence the name *pebrine.* Under the microscope these stains assume the form of small mobile granules like bacteria, which Cornalia termed vibratile corpuscles, on account of their movements. Finally, Osimo and Vittadini ascertained the existence of these corpuscles in the eggs, and consequently showed that the epidemic might be averted by the sole use of healthy eggs, of which the soundness should be established by microscopic examination.

It was at about this date (1865) that Pasteur undertook the exhaustive study of pebrine; but Béchamp was the first to pronounce the disease parasitic, resembling muscardine in this respect, and caused by the attacks of a microbe—or microzyma, to adopt Béchamp's name—of which the germ or spore is derived from the air, at first attacking the silk-worm from without, but multiplying in its interior, and developing with its growth, so that the infected moth is unable to lay its eggs without depositing the spores of the microbe at the same time,

and thus exposing the young grub to attack as soon as it is born. Pasteur's own researches soon induced him to adopt the same view. The pebrine microbe was long regarded as a true bacterium, successively described as *Bacterium bombycis*, *Nosema bombycis* (Fig. 5), and *Panistophyton ovale*. Balbiani's recent researches tend to show that it should be assigned to another group, much nearer to animals, and designated *Sporozoaria*. These protista, still regarded as plants by many naturalists, chiefly differ from bacteria by their mode of growth and reproduction, in which they resemble the parasitic protozoaria, termed *Psorospermia*, *Coccidies*, and *Gregarinidæ*.

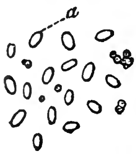

Fig. 5.—*Nosema bombycis*, pebrine microbe (× 500 diam.).

In *Sporozoaria*, growth by fission, the rule in all bacteria, has not been observed; this distinction is fundamental. Sporozoaria multiply by free spore-formation in a mass of sarcode substance (protoplasm), resulting from the encysting of the primitive corpuscles (mother-cells). The formation of numerous spores may be observed within the mother-cells, having the appearance of *pseudonavicellæ* or spores of gregarinidæ and psorospermia (parasites of vertebrate animals). Balbiani forms these organisms, which are found in many insects, into a small group, which he terms *Microsporidia*.

The ripe spores are the vibratile corpuscles of Cornalia. They closely resemble the spores of some bacilli (*B. amylobacter*, for instance), and their germination is likewise effected by perforation of the spore at one end, and issue of the protoplasm from the interior. This, however, does not issue in a rod-like form (*Bacillus*), but in that of a small protoplasmic mass, with amœboid movements, a characteristic not observed in any bacterium (Balbiani). The other species of silk-worms which have been recently introduced, notably the oak silk-worm from China (*Attacus Pernyi*), are attacked by microsporidia analogous to those of pebrine.

Pasteur has indicated the mode of averting the ravages of this disease. He has thus addressed the breeders: "If you wish to know whether a lot of cocoons will yield good seed, separate a portion of them and subject them to heat, which will accelerate the escape of the moth by four or five days, and examine them under the microscope to ascertain whether corpuscles of pebrine are present. If they are, send all the cocoons to the silk-factory. If they are not diseased, allow them to breed, and the seed will be good and will hatch out successfully. In a word, start with absolutely healthy seed, produced by absolutely pure parents, and rear them under such conditions of cleanliness and isolation as may insure immunity from infection." When the disease is developed, fumigation with sulphurous acid is recommended, or preferably with creosote or carbolic acid, which do not affect the silk-worms (Béchamp), and which hinder the development of microsporidia. These fumigations likewise keep the litter from

becoming corrupt, and in a properly conducted nursery the litter is kept dry.

Wrongly confounded with pebrine, the disease *flacherie* is still more destructive to silk-worms. The symptoms are remarkable. The rearing of silk-worms often goes on regularly up to the fourth molt, and success seems assured, when the silk-worms suddenly cease to feed, avoid the leaves, become torpid, and perish, while still retaining an appearance of vitality, so that it is necessary to touch them in order to ascertain that they are dead. In this state they are termed *morts-flats*. A few days, sometimes even a few hours, suffice to transform the most flourishing nursery into a charnel-house. Pasteur examined these *morts-flats*, and found that the leaves contained in the stomach and intestine were full of bacteria, resembling those which are developed when the leaves are bruised in a glass of water and left to putrefy (Fig. 6). In a healthy specimen, of good digestion, these bacteria are never found. It is therefore evident that the disease is owing to bad digestion, and becomes rapidly fatal in animals which consume an enormous amount of food, and do nothing but eat from morning to night. The digestive ferments of unhealthy silk-worms do not suffice to destroy the bacteria of the leaves, nor to neutralize their injurious effects. These bacteria are really the cause of the disease, for if even a minute quantity of the leaves taken from the intestine of diseased silk-worms be given to healthy specimens, they soon die of the same disease. It is, therefore, essentially contagious, and, in order to prevent the diseased silk-worms from contaminating the healthy by soiling the leaves on which the latter are about to feed, as much space should be assigned to them as possible.

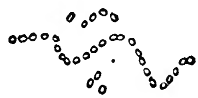

FIG. 6.—*Micrococcus bombycis* (Cohn), *Flacherie* microbe (× 500 diam.).

Good seed should also be selected, since it has been ascertained that some lots of seed are more liable to the disease than others. The affection does not indeed begin in the egg, as in pebrine, but the question of heredity comes in. It is clear that, when a silk-worm has been affected by *flacherie* without dying of it, its eggs will have little vitality, and the grubs which issue from them will be predisposed by their feeble constitution to contract the disease.

A PSYCHOLOGICAL STUDY OF FEAR.

BY CHARLES RICHET.

THE study of fear, although it is very interesting, has hardly yet been made in a methodical way. While some ingenious observations concerning it may be found in moral and psychological works, the physiologists and philosophers appear to have neglected this

humble emotion. The instructive work of the Italian, M. Mosso, gives an excellent physiological study of the physical phenomena of fear, but is almost the only treatise that bears on the subject. It is our purpose to look at it from the point of view of general psychology, and of the relations of man with animals; and to inquire into the effects and causes of fear among all beings capable of feeling it.

We have, first, to describe the signs of fear and the physical phenomena that accompany it. With man, the testimony of his own consciousness is sufficient. With him fear may be wholly internal and translated by no apparent sign; but he can also afterward give account of his experiences. With animals the case is different. Their only language is their attitude. Our only resource for discovering the emotions by which they may be stirred is by the exterior signs they may give of them; and then we can only draw our conclusions by analogy. My horse all at once raises his head, droops his ears, shies, and starts on a gallop. There was a white cloth before him, and I conclude that he was afraid of it. Have I any right to draw such a conclusion? To affirm it with certainty in every particular, I would have—to use a vulgar expression—to be in his skin; for what I saw does not rigorously prove that my horse had a feeling identical with the one I am acquainted with from having suffered it myself, and which I call fear. Still, I have every reason for believing that the horse's feeling is of the same kind; for his attitude is the same when it thunders or when he hears a violent detonation, things which provoke fear in man; moreover, various other quadrupeds assume nearly the same attitudes when they are surprised by an unexpected object.

When we come to the lower animals it is extremely difficult to determine the operation of fear among them. When frogs hastily leap into the water and swim for their holes at the passing of any animal along the edge of the marsh, is it fear that has moved them? Very likely, although their physiognomy has not changed—for they have none—and we are not able to pass any judgment with regard to the phenomena of consciousness they may have experienced. We all agree that something has affected them that resembles fear in man.

Fear acts in two ways. At times it paralyzes and makes motionless; at other times it excites and gives extraordinary strength. One person overcome by it remains fastened to the spot, pale and inert; his legs give way, and all his forces fail him. Another person scampers away like a rabbit. Fear gives him wings, and he abandons his unhappy companion, who is not able to move, while he has already put himself out of danger. At the same time special physical phenomena are manifested, which can not be described better than in the language of the poets and the common people. The hair stands out on the head; the body is seized with trembling and with a general shiver, and the teeth chatter so that they can be heard. The hands shake so that they can not grasp anything; the legs give way; a

profuse, cold, clammy perspiration covers the body; the skin feels shivering, and the hair-bulbs over it swell up and harden. A convulsive thrill, with a feeling of cold, runs down the body, from the nape to the toe, coursing along the back at intervals like a cold electric wave. The face grows pale, and the heart beats violently, as if it would burst out of the chest; or else, perhaps, it almost stops, producing a feeling of indescribable distress. The pupils dilate, the eyes open wide, and the features assume a repulsive aspect, which has been well represented by the great painters. The voice sticks in the throat, and the victim of the emotion is speechless. These are the manifestations of fear in one of its highest forms. They are less evident in moderate fear, according as it is moderate; while the most intense degree of emotion produces syncope, or arrest of the movements of the heart.

The syncope is rarely prolonged till death ensues; but well-authenticated cases are on record in which death has resulted immediately, while simple syncope is quite frequent. Most of the physical effects of fear, in fact, the pale face, the general weakness and paralysis, the buzzing in the ears, and the vertigos, are symptoms of syncope; and when they accompany sudden fright they are probably less due directly to the fright itself than to the arrest of the movements of the heart which it provokes. This profound emotion of fear, with its accompaniment of violent external phenomena, is fatal and involuntary, and is a reflex action, provoked by an irresistible force, independent of ourselves.

Besides the physical reflex actions, well known to physiologists and often described, I have defined a class of psychical reflex actions. Ordinary reflex actions, like the contraction and enlargement of the pupil under varying intensities of light, are dependent on the most simple excitations and require no intelligence, comprehension, or mental elaboration. Other reflex actions are of a different character. They are reflex, in that they are involuntary; and conscious, in that we can give a complete account of them; but they are also psychical, in that a considerable degree of intelligence is required for them to occur. Take, for example, the simple instance of the soldier who dodges when he hears a bullet whistling near him. The motion is entirely reflex, for the poor fellow has dodged before he has even thought of the ball that might hit him; but it is also conscious and psychical. A number of analogous actions might be cited; and if we give the subject a little attention we shall find that they play an important part in our everyday life. The conscious moral emotion and the exterior movement accompanying it are caused by a sensible excitation which in itself is nothing, but is transformed by the mind so as to become effective. The whistling of a bullet as a mere noise would not cause one to dodge. It is a noise which, in itself, is quite incapable of provoking such a movement. If, then, the soldier dodges so abruptly, it is be-

cause the whistling of the bullet has a significance to him. He knows, without having thought long about it, that it is death passing by him. And before he has performed any conscious reasoning concerning the effects of a whistling bullet, the association of ideas has worked in his mind and determined his sudden movement.

If, while an athlete was performing his exercises on the trapeze, one of the cords should break, the host of spectators would be overcome by great emotion. Some of the women would turn away sick, and others would scream ; and the bravest would shiver and turn pale. These phenomena are certainly involuntary and reflexive ; but they could not exist without some intelligent comprehension of what has taken place. The breaking of a cord is not an excitant of reflex actions, and, if there were no man's life in the case, the crowd would not feel them.

The lower animals are not susceptible of having psychical reflex emotions, only simple ones ; for they have no knowledge, and no judgment respecting the nature of the exciting cause. Many of man's reflex acts are of similar character, as the flow of tears, the reddening, and the vigorous winking when one gets a speck in his eye. Nearly all the psychical reflex acts have as their starting-point an excitation of the senses. Such excitations can not of themselves be competent to provoke an organic reflex movement ; but, if they are comprehended by an intelligence, and are accompanied by a notion of the exterior phenomenon, they can then determine a reflex act which is the consequence of that notion.

Thus, fear, as a psychical reflex emotion, results doubly : first, in a phenomenon of consciousness, or the fright felt by the me ; and, second, in a series of characteristic reflex motive phenomena. The whole central nervous system is disturbed, and the disturbance is communicated to all the motive and glandular apparatus : to the heart, whose beatings are arrested or accelerated ; to the muscles, which vibrate ; to the salivary glands, which cease to produce saliva ; to the intestines, which contract with force ; to the vessels of the pallid face ; to the sudoriferous glands ; to the dilating pupil ; and to the features, which reflect the distress of the consciousness.

M. Brown-Séquard has proved by numerous experiments that the nervous system, when it has been subjected to an exterior stimulation, may be excited or paralyzed. The emotions of fear are likewise either stimulating or paralyzing, or inhibitory. Examples of both kinds of effect are numerous. Thus, when a rabbit is overtaken by a dog, it runs away immediately, the faster the more it is frightened. It will leap over wide ditches, pass through almost impenetrable hedges, and strike against objects it would ordinarily avoid, so much is its course precipitated by fear. If the dog pursues it, it leaps and bounds here and there, frightened out of its wits, but more agile and fleet in consequence of its very terror. Another rabbit, under precisely similar

circumstances of pursuit, instead of fleeing, remains still, for the sight of the dog's ardent eyes has inspired in it a fear of a character that will not permit it to withdraw its gaze. It is nearly paralyzed, and is incapable of running away, and fear, instead of making it run, prevents its running. Thus the same emotion is translated by an inhibition in one case, and by an excitation in another.

Very intense fear is generally inhibitory, or paralyzing in its effect, while a lighter fear works an increase of strength. It is known that anger develops muscular force to an extraordinary intensity. This is still more true of fear. A person who is running in fright will leap over obstacles which he would be wholly incapable of overcoming in his normal condition. Numerous experiments show that the brain exercises an inhibitory action over the reflex movements, and that the more active that organ, the more they are under control. It is the will that exercises this power. Fear, likewise, may be modified and regulated, to a certain extent, by the will; and this is one of the most curious and mysterious phenomena in the history of the emotion.

We have said that psychical reflex emotions do not depend solely on the exterior excitation that disturbs the organism, but largely upon the elaboration of that excitation by the intelligence. The whistling of the bullet that makes the soldier dodge, the roaring of the lion which makes the dog tremble, the smell of the elephant which terrifies the horse, are in themselves indifferent excitations. They have power over the emotions only when they fall upon an intelligent organism which comprehends, with more or less of knowledge, what they mean. Hence the intensity of the fear does not depend upon the excitation itself, but upon the response of the organism to it. It depends upon our individual excitability, which is variable. Some men are naturally brave, others are naturally timid. Children are generally timid, women not so brave as men, and nervous persons less brave than phlegmatic ones. There are also bold and timid animals.

It is probably wrong to use, in distinguishing between individuals, the terms bravery and timidity. A nervous, timorous, and impressionable person may be extremely brave. He may, besides, be all the more deserving for that; but his temperament makes it easy to startle him; and it is hard to find a word to express his exact character. An extremely nervous woman may be capable of performing deeds of extraordinary bravery; but that does not prevent her suffering from fear. It is necessary, then, to distinguish between the emotion, of which we are not masters, and the acts which it commands. There are two elements in fear: the sensational element, or the emotion provoked in the consciousness; and the active element, or the series of acts which it induces. But in these acts it is necessary to distinguish between real actions performed by ourselves, and organic, visceral, and involuntary motions. The famous saying attributed to Turenne expresses a profound psychological truth bearing upon this point.

When the battle had begun and the bullets and shot, rattling about him, made him tremble, he remarked to himself: "You are trembling, carcass of mine; you would tremble more if you knew where I was going to take you!"

In fact, the feeling of fear can not be subdued. It is an irresistible emotion that depends upon our organization, and one which all the most logical reasonings can not change. Nothing is more true than the common saying that fear does not reason; and it is remarkable how little efficacy intelligence and its efforts have to arrest its effects. I know a highly intelligent person, with a strong and clear mind, who believes he would be lost if he had to go into a boat. Yet the sea is smooth, the course is short, and the boat stanch. Excellent reasoning, but it does not take hold of him. His emotion is stronger than all the arguments you can invent, however irreproachable they may be, and no matter how fully the poltroon may recognize their force. How many children there are who do not dare to cross in the night the garden where they have played all day, where they know there is no danger, and where they will not lose sight of the lights in the house!

An instance out of my own experience will go to show how fear does not reason. About ten years ago, when I was in Baden, near the Black Forest, I was in the habit of walking alone in the evening till late in the night. The security was absolute, and I knew very well that there was no danger; and, as long as I was in the open field or on the road, I felt nothing that resembled fear. But to go into the forest, where it was so dark that one could hardly see two steps ahead, was another thing. I entered resolutely, and went in for some twenty paces; but, in spite of myself, the deeper I plunged into the darkness the more a fear gained possession of me which was quite incomprehensible. I tried in vain to overcome the unreasonable feeling, and I may have walked on in this way for about a quarter of an hour. But there was nothing pleasant about the walk, and I could not help feeling relieved when I saw the light of the sky through a gap in the trees, and it required a strong effort of the will to keep from pressing toward it. My fear was wholly without cause. I knew it, and yet I felt it as strongly as if it had been rational. Some time after that adventure, I was traveling at night, alone with a guide in whom I had no confidence, in the mountains of Lebanon. The danger there was certainly much greater than around Baden, but I felt no fear.

The only effective means of obtaining the mastery over fear is by habit. It is with the moral emotions as with muscular exercise. To become a good walker one must be trained to it, by accustoming himself to greater and greater efforts every day till he arrives at the full extent of his powers. Habit has such an effect upon fear that nothing that is usual to us can make us afraid. Hence the frequency and ease of what is called professional courage. That kind of courage is

not real courage; it is habit. The sailor on the tempest-driven ship; the doctor, the sister of charity, and the attendant in a pest or cholera hospital; the chemist and physiologist surrounded by infections, explosives, and poisons; the aëronaut; the roofer, and the bull-fighter, do not exhibit the test of bravery. They are not afraid. The presentiment of an unknown danger, which is the foundation of all fear, does not exist for them. Operatives who work in factories of powder or dynamite are sometimes so imprudent and so little afraid of a danger which they are perfectly well acquainted with, but to which they are habituated, that it has become necessary to protect them against themselves, and to take rigorous measures to keep them from smoking and from using fire near the powder. Real courage, as distinguished from professional courage, is the fearless confronting of a danger of which we recognize the importance and which we are not accustomed to.

Nothing is more variable than fear. It depends upon the individuality, or, rather, upon the excitability of each individual. Every one has his peculiar quality of excitability, which depends upon his physiological and moral condition, and is not the same for the different excitations. I believe that every man is more or less susceptible to fright; but that fear is caused among different persons by different motives. One is afraid of poisons, another of boats; one of bridges and mountains, another of snakes; another of darkness or of thunder; and each one can find among the excitations that strike upon his senses the one which will be most apt to provoke in him fear. The excitability of each person is also variable according to the time of day, or to his condition in health or disease. The thoughts do not follow the same course in a person who is hungry and in one who has just dined. A convalescent, debilitated by a protracted nervous affection, would doubtless be more accessible to fear than if he were robust, well, and just rising from the table. Attention and the imagination enormously augment the intensity of the emotion. In fact, for all psychical reflex phenomena the excitement is nothing in itself; the reaction of the organism does all. The visual or auditive image which strikes our senses is nothing, so long as it is not transformed and elaborated by the intelligence in such a way as to become at last a frightful image. A child walking on the road at night sees a white cloth swinging in the air; he immediately imagines it a ghost in pursuit of him, and runs away terrified. His imagination has done it all, and if it had not amplified and immeasurably magnified the real image he would not have been afraid. Perhaps we ought all to be more modest than we have been in the habit of being respecting this matter of bravery, and to acknowledge that to be bold is often simply to lack imagination.

In some cases the imagination is blended with attention. To pay attention to an image is, by the fact itself, to aggrandize it and make

it important, to give it relief, vividness, and force. Suppose one person should warn another that he is going to prick him with a pin at a particular point in the skin. For some minutes that pin-prick will have a menacing presence. All the force of the victim's attention will be borne upon it, though it is really inoffensive, and the thought will finally become almost painful. If the same prick had surprised him without his having had time to think about it and concentrated attention upon the insignificant wound, it would probably have passed off unnoticed. But by virtue of attention it has become a great matter. So we may prepare for something we dread, and the long preparation will contribute to double our fear of it. Thus attention is, as well as imagination, an excitatory force, and may render extremely sensitive to fear persons who, without it, might have been bold to insolence. It is true that attention is voluntary to a certain point. We may, it is said, turn away our thoughts to some other subject. But attention can be commanded only when indifferent matters are in question. Violent imaginings and strong emotions command it and are not commanded by it. Thus, from whatever side we regard the problem, we shall find that fear, whether as a sensation or as a conscious emotion, is dependent on our individual excitability and is quite independent of the will. Yet the will may intervene; but, however powerful we may suppose it to be, it has no effect on our feelings, but only on our acts.

The soldier who hears the bullets whistling around him can not control his emotion, which is legitimate; but, by an effort of the will, he can keep from running away and continue to march on. Perhaps a still stronger effort of the will would be required to arrest the psychical reflex movement of dodging, but that is also possible. The will is, therefore, equivalent to a power of inhibition. The power is variable among different persons, and this variability occasions the different degrees of courage.

We have here, apparently, an antagonism between two contrary forces: on one side is the emotion, which incites to certain acts; on the other side is the will, or inhibitory power, which prevents those acts. It seems that when we are stirred by an emotion it can be best opposed by an inverse emotion. The soldier in battle is sustained against his fear by the honor of the flag, the sense of personal dignity, the presence of his chiefs and comrades, ideas of duty and discipline, fear of chastisement, love of country, the hope of reward, and other strong motives. But the soldier's will and the factors that re-enforce it have no control over his organic movements. Though he can resist the inclination to run away and to dodge, he can not hinder himself from trembling and growing pale, or prevent the violent beatings of his heart and the cold sweat. It would therefore be unjust to reproach a person who has passed through a great danger for having become pallid and quaked. Turenne quaked, and he was not a coward.

There are, then, two kinds of bravery—that of the person who does not suffer from fear, which is easy and of little merit, and the bravery of a person who overcomes his fear. Such a person, in my opinion, is more courageous than any other ; but, though I have great respect for him, I should put but little confidence in him, for his heroic effort may be overcome at any time, and virtue, beautiful as it is, is less solid than absence of emotion.

He who is overcome by fear and runs away with all his might is certainly not brave, and is not entitled to any eulogy ; but we should be indulgent to him. Who knows whether, with a few words of encouragement or enthusiasm, or by becoming accustomed to danger, he might not have been able to conquer his innate sensibility ? Doubtless the bravest also have their moments of failure ; even if they have not yet had them, the time may come when, surprised by a violent, sudden, and irresistible emotion, they will not be strong enough to triumph over themselves.

We begin the inquiry into the function of fear in the animal economy with the assertion that none of the natural feelings are for nothing. Whatever theory of the origin of beings we adopt, we are always forced to recognize that everything within us serves some end. Fear shows us where danger lies, creates aversion to that danger, and forces us to flee from it, and is, therefore, a protective instinct. We need to be protected. If we had only our intelligence to inform us of danger, we should be very frequently in peril, and our existence would be greatly abbreviated. Nature seems to have a great distrust of intelligence, and to have given it an insignificant part in our self-protection. Emotion comes in first, and intelligence afterward. Wounds that make blood flow are dangerous to the organism ; but, if we had to be convinced of the danger from this source to save ourselves from it, men would long ago have disappeared from the earth. Nature has taken the simpler way of endowing us with such sensitiveness to pain that we avoid being wounded, not because the wound lets the blood flow, but for the more evident reason that it hurts us. So we avoid exposing ourselves to danger, not because it is danger, but because we are afraid.

Of the two elements in fear, the internal emotion, of which the consciousness takes cognizance, and the reflex action, all beings have the reflex element ; but the emotion, so far as we can perceive, does not appear to be equally present in all. Apparently, it is more powerful the more intelligence is developed ; and inferior, unintelligent beings, feel neither pain nor fear with as much force as man. In passing from the brute to man, fear is transformed and generalized. With the animal it is instinctive, answering to no idea. The hen is afraid of the fox, without knowing that the fox may eat it ; the gudgeon of the pike, without thinking of its voracity. The horse shies at the sound of thunder, without knowing that lightning can kill him.

They are afraid without knowing why, perhaps even without knowing that they are afraid, while man, with his highly developed consciousness, has a perfect knowledge of his fear. Both man and the brute have in the same degree love of life, dislike of death, and fear in the face of danger. But the notion in the animal is so vague and indistinct that it hardly exists; it is translated by acts the significance of which escapes the actor himself, while in man the same idea becomes precise, reasoned out, and conscious. What we call the instinct for self-preservation is only one of the forms of fear. A violent and irresistible emotion takes possession of our whole being when we perceive ourselves in the face of death, and is the manifestation of a love of life and dread of death that every man bears within himself. It requires real courage to do violence to this general and deep instinct.

We have, therefore, the following progression: The animal, by a simple reflex movement, reacts to excitations that threaten its life; and this reflex movement is admirably adapted to the necessities of its existence.

Next the reflex movement becomes more and more complicated, into a movement of the whole—with flight, outcry, and tremor.

Then, as the animal becomes more and more intelligent, emotion accompanies the action, till the animal not only responds to the menacing excitations by a movement of flight, but has also a conscious feeling of fear.

Finally, a superior degree of perfection appears in man. Besides the act and the emotion, intelligence is displayed, and the man comprehends why he is afraid.

The study of the reactions of the animal shows to what point all the instinctive movements provoked by fright are exactly conformed to the necessity of living, which Nature imposes upon each of her children. When a danger comes which it is necessary to escape, every animal has two means of deliverance. It can flee precipitately, or it can hide and keep still. I believe that the paralyzing and stupefying action of fear, which is manifested in man as well as in the animal, is a salutary instinct, which is probably transmitted from the animal to man, and which, if it is not useful to man, is evidently quite so to the animal. The reaction of immobility is so complete with some animals as to simulate death. There are various insects which, when they are touched, feign to be dead. Every animal has its special kind of reaction. The butterfly flutters in capricious *détours*; the turtle withdraws into its shell; the bee, surprised by an enemy, stings him; the cuttle-fish empties its ink-bag; the hedgehog rolls himself up into a ball; other animals utter piercing cries. These are all reactions that represent different means of defense.

In studying the causes of fear, it is well to lay aside all rational and reasoned causes. When we know that our life is threatened, our

fear is easily explained as the result of the knowledge. A man who is bound to the mouth of a cannon experiences a very strong fear; but, though legitimate, it is not a natural fear in the zoölogical sense of the word. He is in fear because he knows that his life is in danger; but this is a thought-out fear, reasoned and intelligent. Man's rational fears are the fear of death, the fear of pain, and the dread of disesteem. To the fear of death are ultimately referable all emotions of fear, whether conscious or not. Pain is a motive for dread even when it is not mortal, as, for example, in the case of a patient who is awaiting a surgical operation. A more curious kind of rational fear is the fear of disesteem, which is felt by the orator about to make his address, or the actor of any kind to perform his part before the public. It can be assimilated, I think, to the dread that is felt by the patient about to undergo an operation, but is aggravated by the circumstance that, while the patient has only to be passive, the actor knows that the judgment of his audience will depend on himself. In a milder form, it is timidity, such as is shown by young people still unused to society. We shall not enter into the psychological history of these moral fears, interesting as it might be. Nor shall we dwell upon the terror which is determined by the thought of danger and threatened death, for those feelings do not explain the origin of fear. Only the unthought fears can aid in that research.

There is a peculiar feeling, which does not seem identical with fear, though it is of the same character, which may be described as the vertigo of height. It is brought on by the view of a great depth. There is nothing rational in it, for there is no more danger of falling from a great height than from a slight elevation; and a slight barrier, even too slight to afford any real protection, is often sufficient to remove it. But it serves a protective purpose, in guarding us against the perils of elevated places. It is an excellent example of the psychical reflex affection, embodying all of its conditions of being involuntary, conscious, dependent on the sense of sight, and variable with different persons; and it is easily modifiable by education and habit.

The emotion excited by a sudden, violent noise is analogous to fear. It might be described simply as a rudiment of fear; a physical disturbance, or a visceral emotion, producing a momentary response in the mind. Many persons, for instance, are afraid of the sound of thunder. The noise of the storm tends to heighten the effect; and it is likewise observable in animals which, in tropical countries, show great distress during earthquakes and storms, and are also peculiarly sensitive to strident noises.

A loud noise, even when it is not unexpected, always causes a kind of surprise, which is manifested by winking and a general thrill, with palpitation of the heart. During the exposition of 1878 I watched the movements of parties of visitors who stopped to observe the operation

of a pile-driver which thumped down every two or three minutes upon a post. The bystanders would shut their eyes at every crash of the machine, and I was not any more able than they were to keep from doing so.

Three other conditions favorable to the excitation of fear are those of the unknown, of darkness, and of solitude. The fear of the unknown has been named *misoneism, μῖσος, dislike; νέος, new*); or, to use a more familiar etymology, *neophobia*. It is best exemplified in children and savages; for in mature man use and reason have, as a rule, intervened to correct the instinctive feeling. An infant is nearly always afraid at the first sight of a strange animal, even though it be not very large, but may soon become accustomed to its presence. To savages also, whose intelligence is of an infantine grade, everything that does not enter into the line of daily objects is the subject of fear, when it is imposing in size and vigorous in movement, or of simple amazement when it is small and appears inoffensive. Higher minds, instead of shunning novelty, seek it eagerly. In the student, curiosity takes the place of neophobia. But that curiosity implies a degree of courage; for every unknown thing supposes a possible danger, and real complete security exists only in the face of objects the innocence of which we have tested. We are thus brought back by a rather tortuous way to what we have already said of habit, exercise, and professional courage.

Animals that are used to see man frequently cease to fear his presence. Domestic animals have no such fear of man as wild animals show. Animals also which have never been hunted show no fear when a person comes among them. The most cowardly animals are those which have been most actively pursued. The character of being wild and easily frightened seems to be one that is transmissible to descendants. Since there is no reason for fear existing when there is nothing threatening, the emotion in animals can be explained only by the fact that for series of generations they have been obliged to sustain themselves by flight against aggressors upon them. Neophobia, therefore, should be met among those animals which have experienced dangers, or whose ancestors have experienced dangers. It does not have to be shown that nearly all animals come under these conditions. The more unknown the unknown, the greater is the fear; and the fear of what are supposed to be supernatural phenomena is, where it exists, extremely great.

The effect of darkness in increasing or creating fear is explained by reference to the unknown as a principal cause of the emotion. Darkness is, in fact, the unknown. Light is the one of all the senses that tells us most clearly what is around us; and when it can not perform its part we are of necessity unquiet and troubled. A man traveling in the open field in the full light of day sees everything around him, and goes on boldly in the knowledge that no enemy can escape his

view. But if he is in a thick forest in the darkness of night, he imagines vaguely and without acknowledging it that the gravest of dangers may be awaiting him a step or two farther on. He may not think of particular dangers, but he is simply suffering from a causeless obscure fear that can not be justified. The darkness prevents him from seeing and distinguishing anything, and the mass of shade around him conceals the unknown, that is, possible danger or something frightful. Children and nervous women, being of a more excitable nature, are more sensitive to this influence than men, who are more able to check their emotions by reasoning. But I believe that no one can withdraw himself completely from it. This fear is also common to animals. All horsemen know that their horses are easily frightened during the night, especially when they are traveling on a road that is new to them.

Another condition, which contributes greatly to augment fear, is solitude. It is an abnormal condition. Man is before everything a social animal, and he can not effectively protect himself unless he is sustained by some of his fellows. Hence that need of society under which a danger shared is confronted cheerfully and resolutely, while a danger to which one is exposed alone is often intolerable. This is the fact aside from the influence of self-respect and false shame, which, however, do not fail to play a part in the matter. We frequently check the manifestations of fear so that no one may witness our cowardice. Perhaps none of us would be brave if we were not seen by anybody. On the word of all men who have encountered real dangers, solitary courage is the hardest and rarest. Fear is augmented in solitude, by the thought that we are not protected by any one. Unless we have extreme confidence in ourselves, the feeling of helplessness under such circumstances becomes insupportable, and this without regard to whether our fear is justified or not. The company of any one, even of an infant or an infirm person, is enough to reassure us. The most manifest sign of solitude is silence. A man must be really brave to resist the triple trial of the unknown, darkness, and solitude with silence. Let a familiar sound—the song of a bird, the striking of a clock, the noise of the sea or the wind, the rolling of a carriage, or a human voice—be heard in this solitude, and what a relief!

If we now look at the symptoms and causes of fear as a whole, we shall be able more clearly to understand the simple law that connects all the facts. All living beings are organized to live, and all their emotions and actions are conformable to this great purpose. Hence we have protective emotions or reflex phenomena, which cause us to flee from danger without intelligence and consciousness having to intervene, of which fear is one.

Man, whose intelligence can reach the causes and the laws of phenomena, knows that he must live, and the love of life is so solidly planted within him, that all that offend life—pain and death—offer

motives for fear. If a person is afraid, it is because the images of pain and death are before him.

Fear is, therefore, on final analysis, a protection against death. But salutary as it is, and inspired by nature, the feeling is one that must be energetically contended against, because it is an emotion of the lower class which it is necessary to try to dominate and make submissive to the moral conditions of our existence. We should try to conquer ourselves, and replace the notions of terror by the higher ideas which will perhaps triumph over fear, of self-forgetfulness, abnegation, duty. These ideas will certainly not be without use; but a more effective means, perhaps, though a more humble one, is to habituate one's self to danger, and look in the face as often as possible, but without bravado and without anxiety, the figure of the death which awaits us all.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

SOME PECULIAR HABITS OF THE CRAY-FISH.

By C. F. HOLDER.

IN hardly any other order of animals do we find such a diversity of habits as among the crustaceans, that include the crabs, lobsters, shrimps, etc. Some are of the sea, others of the land, and others of either; in fact, there seems to be no condition in life they do not share. They are found in the deep sea, and floating on the surface in the Gulf Stream. Some are luminous, others transparent, or have the faculty of changing color. Certain species live in caves, finding their homes in subterranean streams. Others, again, are found in hot springs or in the icy sludge of the Arctic Ocean, while in the south or Antarctic region we have a group that are attached to the wings of birds, thus leading a roving, migratory life. From this hasty glance at the possibilities of "crab-life," we may expect almost anything and not be surprised.

Some weeks ago I left Chicago for a short trip on the Northwestern Railroad up into Northern Illinois. The trains do not make particularly fast time, allowing the tourist an opportunity to obtain a more than casual glance as they move along. In observing the fields and farms in this region, I was struck with one peculiarity not seen in the East. In almost every small valley, especially where there appeared to be a stream, the ground was raised in mounds from eight to twelve inches high, and from six to twelve inches in diameter. Generally they were flat on top, and in almost every case were grassed over the entire surface. A few of these would not have attracted especial attention; but, as we proceeded north, they grew more frequent, and finally patches were seen, several acres in extent, completely covered by the curious mounds. Later on I took occasion to visit one of these

localities, and found the prairie completely covered with them for acres. The majority were along the sides of a sluggish brook that held water scarcely an inch deep, and from here they extended away up the slope, so that the most distant heaps were perhaps two hundred feet away from the stream; and, in some cases observed in other localities, no stream or brook could be found, a low, damp spot being the center from which the mounds seemed to radiate or branch. So vast were the numbers of heaps that I could walk for a long distance by merely stepping from one to another, and not unfrequently they were in such close proximity that walking was difficult: a horse in passing over the field presented a curious appearance, evidently finding it hard work; and a carriage would have been wrenched to pieces or badly strained in a short time. The makers of these mounds or heaps were discovered by digging, and proved to be a genus of the common fresh-water cray-fish; and, though I was familiar with their mound-building habits, their location so far from streams was entirely new, and shows that the little creatures are better adapted to a semi-amphibious life than many of their allies that are considered true water-livers.

In making inquiries and investigations into their habits, I found that they differed from our species of the East in certainly, at times, not requiring water. In other words, they passed a certain portion of the time out of the water, and occasionally they would retreat from it; and when floods came they would leave what would be naturally considered their native element entirely and take to dry land.

In a small river that flows through the prairie north of Freeport, Illinois, I found great numbers of cray-fish close in shore, nearly every stone concealing one or more that were well protected by their almost exact resemblance to the bottom in color. Four or five feet above the level of the water were numerous heaps formed in the black clay mud, and almost every one of these contained a cray-fish that was living in water that must have come from above, as the holes had no connection with the river below. Generally I found the little animal out of water, just within the hole, and upon being alarmed it would drop down. Investigation with a stick would show that there were several inches of muddy water in the bottom. The inmates, having no loop-hole for escape, were quite savage, biting at the intruding stick with their powerful claws, and allowing themselves to be almost lifted from the mound.

It would seem strange to find these animals living in this condition if there were not some rational explanation, and it is evident that too much water is equally as disagreeable to the cray-fish here as, if not more so than, not enough, and the mounds and heaps—above and away from the streams—are in this locality the results of the animals' attempts to obtain a location where they can remain in the water or out in safety. To crawl out upon the open bank of a brook would expose them to

numerous dangers; so, to avoid this, they crawl up the banks and burrow into the saturated mud or soil, and at times penetrating from the stream-bed, the earth or mud thrown out forming the mound, an opening or door is generally left at one side or on top. Water collects in the bottom of this burrow, while the upper portion is entirely free, thus enabling the cray-fish to take to the water or not, as it is inclined. These mounds are probably built when the streams rise, the crustaceans leaving the swift current and taking to the higher ground for better security. To show how a flood or over-supply of water will at certain times alarm these little creatures, a gentleman residing in Freeport, Illinois, informed me that not many months ago they had some very heavy rains, that greatly increased the volume of the little river running through the town. The water gradually rose until numbers of quite large trees were submerged, and the stream was almost twice its ordinary width. Such an unusual occurrence naturally attracted considerable attention, and my informant and a number of others visited the trees several times, and when the river was at the highest they presented a strange appearance from a little distance. Their trunks seemed to have changed color from the water up to the branches, and on closer inspection it was found that they were completely incased with cray-fish which covered every available space, crowding upward by hundreds, clinging to the bark and to each other, in some spots packed one upon another four and five deep; every moment added to the throng, new ones emerging from the water, while those above, urged on, crept out upon the branches, and completely covered them, presenting a novel and interesting sight. The animals in many cases retained their positions for several days, and did not seem to be affected by their stay out of water. The occasion, however, was taken advantage of by the people, who came with buckets and brooms and swept them from the trees by hundreds, storing them up for future use. The cray-fish in certain portions of the Western country is a pest to the agriculturist, and the work of these little creatures often greatly increases the labor and expense of breaking up land, especially after the burrows or mounds have stood for many years, the vegetation that has grown upon them often increasing their size to mammoth proportions, comparatively speaking. Some farmers consider, however, that they enrich the land by keeping it open, and in many other ways, and that land with cray-fish-heaps is worth more to the acre from this cause. To the man who plows his land in the old-fashioned way, as many Germans yet do, the cray-fish is a hindrance and a pest. Not the least remarkable feature of the life of this little creature is the fact of its living so far from open streams. In many cases examined by me, no stream or brook was present, a mere bog being the center of attraction. How they had wandered so far from clear running water was a mystery. Scientifically, the cray-fish belongs to the family *Astacidæ*. About fifteen different

genera are known, nearly half being marine, the rest fresh-water forms. The forms most familiar to us are *Cambarus* and *Astacus.* The latter is common on the Pacific slope and in Europe, while the former is the familiar form of our Eastern rivers and streams, finding their way into the Atlantic Ocean. In many localities their burrowing habits are productive of great damage; this is especially so in the levees of the Mississippi. In some parts of the South they are valued as food, and they can generally be found at Fulton Market, New York, a few people evidently knowing their delicacy in salads, etc. In Europe they have long been used as food, and so great is the demand for them in France that large farms are devoted entirely to their cultivation and breeding, the industry affording a profitable income. A study of the habits of these creatures will well repay the student, as many of them are very curious and interesting. They differ from many of the rest of the ten-footed crustaceans in not passing through the various larval stages that characterize the growth of so many of their allies.

LE PLAY'S STUDIES IN SOCIAL PHENOMENA.

By A. G. WARNER.

WHILE George Eliot was still a writer of essays, she complained that the "psychology of the lower classes" was misunderstood by nearly all who had to do with them, from legislators to novelists. She therefore said approvingly, in reviewing the works of W. H. Riehl, that he was "first of all a pedestrian, and only in the second place a political author." In literature, the work of portraying truly the lower classes has since been prosecuted with zeal by herself and others; but social science still shuns methodic observation.

The number of social facts is so nearly infinite that many have lacked the courage even to begin the work of collecting them. Frédéric Le Play was a man who had the courage.

Not a few of the French economists and students of social science have received their early training in the polytechnic schools of Paris. The lesson which their early education seems usually to have taught them most thoroughly is that of the omnipotence of the human reason; they have too often attempted to reform the world by a dead-lift effort of the intellect. The lesson, however, which Le Play derived from his training in the School of Mines and applied to his work in the study of society was that of the vital importance of observation and analysis. His life in theory-breeding Paris only convinced him that social theorizing was the curse of the French people. In 1824 he came to the metropolis, being then in his eighteenth year, and as during his long life, which lasted till 1882, he watched the kaleidoscopic

history of France, he was more and more confirmed in this opinion. After the fall of Napoleon III, he pointed significantly to the fact that during less than one hundred years France had had ten different forms of government—each one set up and overthrown with bloodshed. Horrified by the carnage of the July Revolution of 1830, Le Play vowed to devote himself to the restoration of "social stability and peace"; and turned a large share of his splendid and effective energy to the study of social problems. A new method was developed, a new school was founded, his followers are still vigorously prosecuting the work along lines which he marked out, and the publications of their societies already number some fifty volumes.

As a mineralogist, Le Play's work was to analyze minerals; as a student of social science, he observed men, and strove to analyze at their very source the influences that shape society. In this work he strove, with all sincerity, to be unbiased by preconceived ideas, and he prepared for and began it merely by practicing what he calls "the art of traveling." In order to complete his studies in the School of Mines, it was necessary for him to make personal observations of some extensive mining district, and, having obtained the means of prolonging his journey beyond the time actually required for mineralogy, he set out, in company with his friend Jean Renaud, for the Harz Mountains and the plains of Saxony. For six months, in 1829, they indulged in an energetic note-taking tramp. But in addition to mineralogy they studied what has been termed "the natural history of German life." Their route was through districts which are part of the territory that Riehl afterward tramped over, and, like the author of "Land und Leute," Le Play recognized the fact that he was studying "history incarnate." The two friends were calculated to be profitable companions, each for the other, because they disagreed almost perfectly as to the interpretation that should be put upon the facts observed. Le Play says that they both became convinced that "the social question" was more complicated than they had at first supposed. But he adds: "I was confirmed in my thought that the solution was to be found in a great measure in the customs of the past. My friend, on the contrary, maintained his belief in the doctrine of 'continual progress,' and, in general, in the importance which in this matter, as in all others, he attached to the spirit of change." Thus we see that Le Play had hardly succeeded in divesting himself of preconceived ideas as completely as he seems to have thought. Though beginning with certain prejudices, and though he collected, before he had pursued his studies far, a most formidable array of theories, yet the paramount need of observation was always his fundamental idea. The methods employed by Le Play and his companion of studying the different facts in which they were interested varied according to circumstances. At times they established stations for study (*les stations d'étude*) near the mines, or factories, or families of laborers, or social

authorities (*autorités sociales*) that they desired to learn of. From here they made excursions into the immediate neighborhood to learn more definitely of the local influences that had to do with with the community they were studying. These were supplemented by geological explorations, by more extended explorations of the whole district, and finally by rapid journeys to entirely different districts and new fields of work. "The art of traveling" was with Le Play indeed an art.

His trip through the Harz Mountains and the surrounding districts was useful to him in two ways: First, his researches as a mineralogist were such as to make him at once prominent in that department and insure his continued usefulness to his government; while, secondly, he had had his liking for social investigation heightened and his ideas regarding the proper method of prosecuting these studies rendered more definite. On his return to Paris he took up his studies at once in the laboratory and in the tenement-houses; and so diligently were his researches subsequently carried on that there is hardly an important section of Europe which he did not finally visit. From Sheffield to the Ural Mountains, and from Norway even across the strait to Tangier, he prosecuted his studies regarding the lives and habits of the peasants and laborers, trying always not only to learn definitely of their environment and industrial life, but trying also to understand their thoughts and their mode of thinking. He considers the family the social unit, and is ever reiterating the idea that as the mineralogist studies the different minerals, or the botanist the different kinds of plants, so the student of social science must examine and analyze the individual families. To obtain systematic and cumulative results he developed a fixed method of observation, and a fixed terminology for recording the facts observed; thus rendering the work, even of different men, definite and comparable. All the facts regarding a given family were to be recorded in a monograph prepared according to an unvarying model. The first sixteen divisions of each monograph are always the same; the facts regarding any family are to be marshaled under these rubrics. Under the head of "General Description" the first five of these are grouped and include—1. Character of the soil, labor, and people; 2. Civil status of the family; 3. Religion and moral habits; 4. Hygiene and healthfulness; 5. Social station of the family. Then, under "Means of Existence," are grouped three of the subdivisions as follows: 6. Property; 7. Subventions; 8. The tasks of the different members of the family. Next, under "Manner of Existence," come—9. Food and meals; 10. House, furniture, and clothing; 11. Recreations. Finally, under the division "History of the Family," we find: 12. Principal phases of its history; 13. Customs and institutions assuring the physical and moral well-being of the family; 14. Budget of receipts for the year; 15. Budget of expenses for the year; 16. Family accounts annexed to the budgets. Beyond the sixteenth divis-

ion we find grouped the "noteworthy facts concerning the community or the family," and here the subdivisions are allowed to vary according to the exigencies of each case.

The mere scrap of a hotel bill found in Falstaff's pocket tells much concerning the character of the "valiant knight"; and when we remember that in these budgets of expenses and receipts which Le Play prepared there is apparently nothing omitted which can throw light on the character and condition of the family, we see how suggestive and useful such a system of social and industrial photography might become in the hands of skillful workmen. All sources of receipts are enumerated, including the house-work of the women, and whatever work may be performed by the children. The production of values in use is reckoned at its estimated worth, but the actual receipts and disbursements of money are kept separate. The classification of the expenses is especially suggestive. The expenses for provisions are classed under seven heads, beginning with cereals and concluding with fermented liquors. Next come the expenses for dwelling and the incidentals of heat and light; then follows the expenditure for clothing; while after this are placed the items of expense for religious purposes, for the instruction of the children, for alms, for recreations and festivals, and for health service. The list of expenses is concluded with the outlays necessitated by the work done, by the interest on debts, by taxes, and by insurance. When, in looking over these systematized account-books, we find that a certain Parisian tailor spends two hundred and ninety-five francs for alcoholic liquors, besides six hundred and eight francs spent in hobnobbing at the cabaret, lost at gaming, etc., we are not surprised to find that he spends nothing for religion, but thirty-four francs for education, twenty francs in charity, and saves nothing whatever. The facts taken together tell us very plainly of his character, and, remembering that Le Play made it a point to study none but typical families, we are brought face to face with some "temperance statistics" of a most suggestive kind. We may also see at a glance the difference in economic condition between the semi-nomadic herdsmen of the Ural Mountains where a family consumes seventy-eight per cent of the products of its own labor and the condition of a watchmaker of Geneva, who, assisted at his trade by his wife, consumes only two per cent of the result of their joint labor without exchanging it for money. With the herdsmen the problem of the distribution of the fruits of labor is unimportant, but with the mechanic it is all-important.

With this patient thoroughness Le Play studied some three hundred families in various parts of Europe; and it was while performing this prodigious work that his methods and theories took shape. In 1855 was published the first edition of his greatest work, "Les Ouvriers Européens." It contained thirty-six (afterward fifty-seven) of the most representative monographs. In January, 1856, the French

Academy conferred upon him the Monthyon prize for statistics, and at the suggestion of the Academy there was founded the Société Internationale des Études Pratiques d'Économie Sociale (International Society for Practical Studies in Social Economy). The first article of the statutes of this society declares that its especial purpose is "to determine by the direct observation of facts the physical and moral condition, in all countries, of those engaged in manual labor, and their relations to each other and to those in other classes." The society is to offer prizes to members or outsiders for the preparation of monographs of special value. Before acceptance all papers or reports are discussed by the society, but the regulations forbid the discussion of any theory not based on observed facts; any one violating this rule may be called to order by the president.

In this organization have gathered all those specially interested in the work of social investigation as planned by Le Play, and from it have radiated the various lines of influence along which the work has been prosecuted. Its founder began in cold blood the writing of a library, and the society has carried forward this work most energetically. They have published already five volumes of monographs, and that the series is not intended to be soon finished is shown by the title, "Les Ouvriers des Deux Mondes" ("The Laborers of Two Worlds"). Another series of publications, "Bulletins des Séances," has reached the eighth volume, and the miscellaneous publications of the individual members are numerous. French consuls, interested in the work, have carried it forward in the remotest parts of the earth. One monograph of the series describes a Chinese peasant community of Ning-po-fou; and the last volume contains an interesting monograph prepared by M. Gauldré-Boileau, the French consul-general at New York, picturing a family of French peasants of Sainte-Irénée, in Lower Canada. As early as 1870 the reports of their discussions contain a consideration of the customs of the Chinese and their emigration to California.

In 1872 Les Unions de la Paix Sociale were founded, an organization intended to be far-reaching and calculated as well for propaganda as for study. Each union is located wherever there may be a group of persons interested in Le Play's theories or methods; local investigations are undertaken, questions pertaining to their work discussed, and through a "correspondent" intimate relations are maintained with the district unions and the central union at Paris. The central union dines monthly, and listens to a synopsis of the month's correspondence. The membership of the organizations has aggregated as many as thirty-five hundred persons. "La Réforme Sociale," a semi-monthly review, serves as organ for both the unions and the Société d'Économie Sociale.*

* In 1885 a disagreement occurred between the leaders, and Demolins, a prominent lecturer, for some time the editor of "La Réforme Sociale," withdrew in company with

Under the patronage of the Abbé de Tourville and others, there have also been developed courses of lectures designed to give instruction to university students or others who may be interested in the "method of observation" and the "art of traveling." Le Play admired greatly the English custom of supplementing university training by a period spent in travel, and hoped, by systematic effort, to develop a similar habit in France. Six courses of lectures in this department have been offered in a single year, which have been attended by about one hundred persons. Some of the students, on completing these courses, have been provided with means to put in practice the precepts taught them, and have gone to other countries to study history, or commerce, or politics.

"The dominant characteristic of my work has been," says Le Play, "the accumulation of innumerable facts, and the incessant gathering together of inductions and conclusions." He tells how, after more than ten years of patient though enthusiastic investigation, he began to wonder how it chanced that in the department of social science he had made none of those discoveries that, in the field of mineralogy, had brought him some renown. Then the thought occurred to him that "in social science there is nothing to invent." And thus the phenomenal Frenchman, who had aspired to be an economist without a theory, proceeded to saddle himself with an assumption as arbitrary as any to which an investigator could well enslave himself. Yet we may notice that acceptance of it need not in any way limit one's activity as a collector of facts, for if there is nothing to invent there must be much to find. But Le Play would not even permit himself to say that he had discovered the truths which he came to believe in, but only that he had refound them. "For," he added, "in social science there is nothing new save what has been forgotten." If only one be an expert quarrier, it matters not whether he supposes himself working at the base of a ruined pyramid or in ledges of living rock. But it is easy to see that, while Le Play was entirely confident that his opinions were the outgrowth of observation, yet in reality his methods of observation were largely shaped by his tenaciously held opinions.

This is still more evident when we come to examine the details of his beliefs and his methods. Wherever he looked he found but two things that are really essential to human happiness: the first is the means of subsistence, the other knowledge of the moral law. Whatever social organization insures these two things to all the members of society, thereby insures to them happiness and peace. The moral law is derived from the nature of man and from the decalogue, which formulates and completes it. He arranges, in parallel columns, "The Decalogue of the Hebrews" and "The Decalogue of the Chinese"

others and began to publish "La Science Sociale," which also claims to follow the method of Le Play.

(gleaned in the latter case from no less than six different writers), to show that they are virtually the same. He denominates it the "Eternal Decalogue," and declares that obedience to it is the first essential of social organization. He enumerates seven essentials to the upbuilding of the social edifice. The first, as stated, is the decalogue, and this, with the second, paternal authority, are the two foundation-stones that must be permanent and inseparable. What he calls the "two cements" are religion and the authority of the state; while the "three materials" are the three forms of land-holding, communal, individual, and tributary.

Surely, Le Play is to be classed with "the social architects," yet he and his followers have always inveighed against "the dogmatists of '89," against the Saint-Simonians, the Fourierites, and all others who believed that they had "discovered" the perfect society while groping amid the shadows of an idealized antiquity, or through the cloudlands of their inner consciousness. The "golden age" in which Le Play believed was not of the past only, nor of the future only, but exists whenever and wherever a people fears God and keeps his commandments. His elaborate specifications regarding "the essential organization" of society claim to be only descriptions of what is always found in a society where peace and happiness obtain. He had labored long and faithfully at the task of social analysis, and, when at length he turned to the work of synthesis, it was his firm conviction that in the three volumes, "L'Organisation du Travail," "L'Organisation de la Famille," and "La Constitution Essentielle de l'Humanité," he did nothing more than bring together the influences which rigidly scientific investigation had proved to be the indispensable sources of man's welfare. Among all the races that enjoy social peace and stability he found the solidarity of the family intact; he found that this form of organization gave the best opportunity for the effective training of the children in the moral law; and he concluded that the chaotic and unsatisfactory condition of the foremost nations of Europe resulted from the breaking down of the almost patriarchal system in which he was learning to believe, from the "infinite morselization" (*morcellement infini*) of interests, from that division of labor which compels the father of a family to be too much of a drudge ever to be a guide, and leaves his children's education to the precarious chances of right management at the hands of various sorts of specialists. He dared to say flatly, for his own country, that her politics and social state were the most unsettled in Europe because her morals were the worst, that her laborers were restless and dissatisfied because they were vicious, because "the system of adultery, instituted with *éclat* at the court of Versailles, had led to the public concubinage which now desolates the Parisian workshops."

A remedy for existing evils, he believed, could not be found by ingenious theorizing, but only by the development and application of

whatever is sound and true in the tradition-wealth of each people. In his thought social organization was an art rather than a science. Though many of the legislative remedies he advocated may seem to us peculiarly trivial and inapplicable, yet we must remember that he regarded laws as merely aids to right development, and for the most part sought to ingraft upon existing French legislation only such special features as had been found helpful elsewhere. By changing the laws of inheritance, or giving more power to the fathers of families, one can not bring again the reign of primitive simplicity. For, despite Le Play's denial, we are not in all respects "the same that our fathers have been." Even though it were admitted that the moral law change not, yet the means of procuring daily bread do surely change, and that continually, and in some measure "invention" must be used in social science to find the proper way of fitting society to the changed and changing situation.

But, in spite of all defects, two special merits belong to Le Play's work in social science. The first is, that he insisted on studying concrete, not abstract "society"; he employed the statistical method. It has been said, to be sure, that "figures always lie"; and certainly charts and diagrams, and brace-synopses that profess to set forth social facts, either past or present, should be accepted with profoundest caution. They are things to be used as Spencer uses them in his "Descriptive Sociology," not as being in themselves final results, but only as a means that may help us in reaching results more nearly final. Social facts are too intangible to make it possible to bottle and label them, once for all, as one may chemicals. The per cent "lost in analysis" is always too large to allow the results to be taken as final. But, after all this has been acknowledged, there remain manifest advantages from even "approximate determinations." Though the methods are not perfect, they are the best that social science has, the only ones that make continuous progress possible. The great mass of work done or inspired by Le Play has already been of use to many students not of his school. Laspeyres has classified and compared his "budgets" with valuable results, and the omnivorous German statisticians have, of course, made use of them.

But, aside from right method and patient accumulation of social data, Le Play should, in the second place, be remembered as one who dared to question the seductive finalities of what claims to be economic orthodoxy; who, in turning from the study of abstractions to the study of men, "refound" the need of insisting always upon not only the social and sociologic, but also upon the economic importance of morality and regard for fellow-man.

UNIVERSAL TIME.*

By W. H. M. CHRISTIE, F. R. S.,
ASTRONOMER ROYAL.

CONSIDERING the natural conservatism of mankind in the matter of time-reckoning, it may seem rather a bold thing to propose such a radical change as is involved in the title of my discourse. But, in the course of the hour allotted to me this evening, I hope to bring forward some arguments which may serve to show that the proposal is not by any means so revolutionary as might be imagined at the first blush.

A great change in the habits of the civilized world has taken place since the old days when the most rapid means of conveyance from place to place was the stage-coach, and minutes were of little importance. Each town or village then naturally kept its own time, which was regulated by the position of the sun in the sky. Sufficient accuracy for the ordinary purposes of village life could be obtained by means of the rather rude sun-dials which are still to be seen on country churches, and which served to keep the village clock in tolerable agreement with the sun. So long as the members of a community can be considered as stationary, the sun would naturally regulate, though in a rather imperfect way, the hours of labor and of sleep and the times for meals, which constitute the most important epochs in village life. But the sun does not really hold a very despotic sway over ordinary life, and his own movements are characterized by sundry irregularities to which a well-ordered clock refuses to conform.

Without entering into detailed explanation of the so-called "equation of time," it will be sufficient here to state that, through the varying velocity of the earth in her orbit, and the inclination of that orbit to the ecliptic, the time of apparent noon as indicated by the sun is at certain times of the year fast and at other times slow, as compared with twelve o'clock, or noon by the clock. [The clock is supposed to be an ideally perfect clock going uniformly throughout the year, the uniformity of its rate being tested by reference to the fixed stars.] In other words, the solar day, or the interval from one noon to the next by the sun, is at certain seasons of the year shorter than the average, and at others longer, and thus it comes about that, by the accumulation of this error of going, the sun is at the beginning of November more than sixteen minutes fast, and by the middle of February fourteen and a half minutes slow, having lost thirty-one minutes, or more than half an hour, in the interval. In passing, it may be mentioned as a result of this that the afternoons in November are about half an hour shorter than the mornings, while in February the mornings are

* Address delivered at the Royal Institution of Great Britain, March 19, 1886.

half an hour shorter than the afternoons. In view of the importance attached by some astronomers to the use of exact local time in civil life, it would be interesting to know how many villagers have remarked this circumstance.

It is essential to bear these facts in mind when we have to consider the extent to which local time regulates the affairs of life, and the degree of sensitiveness of a community to a deviation of half an hour or more in the standard reckoning of time. My own experience is that in districts which are not within the influence of railways the clocks of neighboring villages commonly differ by half an hour or more. The degree of exactitude in the measurement of local time in such cases may be inferred from the circumstance that a minute-hand is usually considered unnecessary. I have also found that in rural districts on the Continent arbitrary alterations of half an hour fast or slow are accepted not only without protest but with absolute indifference.

Even in this country, where more importance is attached to accurate time, I have found it a common practice in outlying parts of Wales (where Greenwich time is about twenty minutes *fast* by local time) to keep the clock half an hour fast by railway—i. e., Greenwich—time, or about fifty minutes fast by local time. And the farmers appeared to find no difficulty in adapting their hours of labor and times of meals to a clock which at certain times of the year differed more than an hour from the sun.

There is a further irregularity about the sun's movements which makes him a very unsafe guide in any but tropical countries. He is given to indulging in a much larger amount of sleep in winter than is desirable for human beings who have to work for their living and can not hibernate as some of the lower animals do. To make up for this he rises at an inconveniently early hour in summer and does not retire to rest till very late at night. Thus it would seem that a clock of steady habits would be better suited to the genius of mankind.

Persons whose employment requires daylight must necessarily modify their hours of labor according to the season of the year, while those who can work by artificial light are practically independent of the vagaries of the sun. Those who work in collieries, factories, or mines, would doubtless be unconscious of a difference of half an hour or more between the clock and the sun, while agriculturists would practically be unaffected by it, as they can not have fixed hours of labor in any case.

Having thus considered the regulating influence of the sun on ordinary life within the limits of a small community, we must now take account of the effect of business intercourse between different communities separated by distances which may range from a few miles to half the circumference of our globe. So long as the means of communication were slow, the motion of the traveler was insignificant

compared with that due to the rotation of the earth, which gives us our measure of time. But it is otherwise now, as I will proceed to explain.

Owing to the rotation of the earth about its axis, the room in which we now are is moving eastward at the rate of about six hundred miles an hour. If we were in an express-train going eastward at a speed of sixty miles an hour (relatively to places on the earth's surface), the velocity of the traveler due to the combined motions would be six hundred and sixty miles an hour, while if the train were going westward it would be only five hundred and forty miles. In other words, if local time be kept at the stations, the apparent time occupied in traveling sixty miles eastward would be fifty-four minutes, while in going sixty miles westward it would be sixty-six minutes. Thus the journey from Paris to Berlin would apparently take an hour and a half longer than the return journey, supposing the speed of the train to be the same in both cases.

In Germany, under the influence of certain astronomers, the system of local time has been developed to the extent of placing posts along the railways to mark out each minute of difference of time from Berlin. Thus there is an alteration of one minute in time-reckoning for every ten miles eastward or westward, and, even with the low rate of speed of German trains, this can hardly be an unimportant quantity for the engine-drivers and guards, who would find that their watches appeared to lose or gain (by the station-clocks) one minute for every ten miles they have traveled east or west. This would seem to be the *reductio ad absurdum* of local time.

In this country the difficulty as to the time-reckoning to be used on railways was readily overcome by the adoption of Greenwich time throughout Great Britain. The railways carried London—i. e., Greenwich—time all over the country, and thus local time was gradually displaced. The public soon found that it was important to have correct railway-time, and that even in the west of England, where local time is about twenty minutes behind Greenwich time, the discordance between the sun and the railway-clock was of no practical consequence. It is true that for some years both the local and the railway times were shown on village clocks by means of two minute-hands, but the complication of a dual system of reckoning time naturally produced inconvenience, and local time was gradually dropped. Similarly in France, Austria, Hungary, Italy, Sweden, etc., uniform time has been carried by the railways throughout each country. It is noteworthy that in Sweden the time of the meridian one hour east of Greenwich has been adopted as the standard, and that local time at the extreme east of Sweden differs from the standard by about thirty-six and a half minutes.

But in countries of great extent in longitude, such as the United States and Russia, the time-question was not so easily settled. It was

in the United States and Canada that the complication of the numerous time-standards then in use on the various railways forced attention to the matter. To Mr. Sandford Fleming, the constructor of the Intercolonial Railway of Canada and engineer-in-chief of the Pacific Railway, belongs the credit of having originated the idea of a universal time to be used all over the world. In 1879 Mr. Fleming set forth his views on time-reckoning in a remarkable paper read before the Canadian Institute. In this he proposed the adoption of a universal day, commencing at Greenwich mean noon or at midnight of a place on the anti-meridian of Greenwich—i. e., in longitude 180° from Greenwich. The universal day thus proposed would coincide with the Greenwich astronomical day instead of with the Greenwich civil day, which is adopted for general use in this country.

The American Metrological Society in the following year issued a report recommending that, as a provisional measure, the railways in the United States and Canada should use only five standard times, four, five, six, seven, and eight hours respectively later than Greenwich, a suggestion originally made in 1875 by Professor Benjamin Peirce. This was proposed as an improvement on the then existing state of affairs, when no fewer than seventy-five different local times were in use on the railroads, many of them not differing more than one or two minutes. But the committee regarded this merely as a step toward unification, and they urged that eventually one common standard should be used as railroad and telegraph time throughout the North American Continent, this national standard being the time of the meridian six hours west of Greenwich, so that North American time would be exactly six hours later than Greenwich time.

Thanks to the exertions of Mr. W. F. Allen, Secretary of the General Railway Time Convention, the first great practical step toward the unification of time was taken by the managers of the American railways on November 18, 1883, when the five time-standards above mentioned were adopted. Mr. Allen stated in October, 1884, that these times were already used on ninety-seven and a half per cent of all the miles of railway lines, and that nearly eighty-five per cent of the total number of towns in the United States of over ten thousand inhabitants had adopted them.

I wish to call particular attention to the breadth of view thus evinced by the managers of the American railways. By adopting a national meridian as the basis of their time-system, they might have rendered impracticable the idea of a universal time to be used by Europe as well as America. But they rose above national jealousies, and decided to have their time-reckoning based on the meridian which was likely to suit the convenience of the greatest number, thus doing their utmost to promote uniformity of time throughout the world by setting an example of the sacrifice of human susceptibilities to general expediency.

Meanwhile, Mr. Sandford Fleming's proposal had been discussed at the Geographical Congress at Venice in 1881, and at a meeting of the Geodetic Association at Rome in 1883. Following on this a special conference was held at Washington in October, 1884, to fix on a meridian proper to be employed as a common zero of longitude and standard of time-reckoning throughout the globe. As the result of the deliberation it was decided to recommend the adoption of the meridian of Greenwich as the zero of longitude, and the Greenwich civil day (commencing at Greenwich midnight and reckoned from 0 to twenty-four hours) as the standard for time-reckoning. In making this selection the delegates were influenced by the consideration that the meridian of Greenwich was already used by an overwhelming majority of sailors of all nations, being adopted for purposes of navigation by the United States, Germany, Austria, Italy, etc. Further, the United States had recently adopted Greenwich as the basis of their time-reckoning, and this circumstance in itself indicated that this was the only meridian on which the Eastern and Western Hemispheres were likely to agree.

The difficulties in the way of an agreement between the two hemispheres may be appreciated by the remarks of the Superintendent of the American Ephemeris on Mr. Sandford Fleming's scheme for universal time (which was subsequently adopted in its essentials at the Washington Conference): "A capital plan for use during the millennium. Too perfect for the present state of humanity. See no more reason for considering Europe in the matter than for considering the inhabitants of the planet Mars. No; we don't care for other nations, can't help them, and they can't help us." *

As a means of introducing universal time, it has been proposed by Mr. Sandford Fleming, Mr. W. F. Allen, and others, that standard times, based on meridians differing by an exact number of hours from Greenwich, should be used all over the world. In some cases it may be that a meridian differing by an exact number of half-hours from Greenwich would be more suitable for a country like Ireland, Switzerland, Greece, or New Zealand, through the middle of which such a meridian would pass, while one of the hourly meridians would lie altogether outside of it.

The scheme of hourly meridians, though valuable as a step toward uniform time, can only be considered a provisional arrangement, and, though it may work well in countries like England, France, Italy, Austria, Hungary, Sweden, etc., which do not extend over more than one hour of longitude, in the case of such an extensive territory as the United States difficulties arise in the transition from one hour-section to the next which are only less annoying than those formerly experienced, because the number of transitions has been reduced from seventy-five to five, and the change of time has been made so large

* "Proceedings of the Canadian Institute," Toronto, No. 143, July, 1885.

that there is less risk of its being overlooked. The natural inference from this is that one time-reckoning should be used throughout the whole country, and thus we are led to look forward to the adoption in the near future of a national standard time, six hours slow by Greenwich, for railways and telegraphs throughout North America.

We may then naturally expect that by the same process which we have witnessed in England, France, Italy, Sweden, and other countries, railway-time will eventually regulate all the affairs of ordinary life. There may of course be legal difficulties arising from the change of time-reckoning, and probably in the first instance local time would be held to be the legal time unless otherwise specified.

It seems certain that when a single standard of time has been adopted by the railways throughout such a large tract of country as North America, where we have a difference of local times exceeding five hours, the transition to universal time will be but a small step.

But it is when we come to consider the influence of telegraphs on business life, an influence which is constantly exercised, and which is year by year increasing, that the necessity for a universal or world time becomes even more apparent. As far as railways are concerned, each country has its own system, which is to a certain extent complete in itself, though even in the case of railways the rapidly increasing intercommunication between different countries makes the transition in time-reckoning on crossing the frontier more and more inconvenient. Telegraphs, however, take no account of the time kept in the countries through which they pass, and the question, as far as they are concerned, resolves itself into the selection of that system of time-reckoning which will give least trouble to those who use them.

For the time which is thus proposed for eventual adoption throughout the world, various names have been suggested. But whether we call it Universal, Cosmic, Terrestrial, or, what seems to me best of all, World Time, I think we may look forward to its adoption for many purposes of life in the near future.

The question, however, arises as to the starting-point for the universal or world day. Assuming that, as decided by the great majority of the delegates at Washington, it is to be based on the meridian of Greenwich, it has still to be settled whether the world day is to begin at midnight or noon of that meridian. The astronomers at Rome decided, by a majority of twenty-two to eight, in favor of the day commencing at Greenwich noon, that is, of making the day throughout Europe begin about midday. However natural it might be for a body of astronomers to propose that their own peculiar and rather inconvenient time-reckoning should be imposed on the general public, it seems safe to predict that a world day which *commenced* in the middle of their busiest hours would not be accepted by business men. In fact, the idea on which this proposal was founded was that universal

time would be used solely for the internal administration of railways and telegraphs, and that accurate local time must be rigidly adhered to for all other purposes. It was conceded, however, that persons who traveled frequently might with advantage use universal time during railway-journeys. This attempt to separate the traveling from the stationary public seems to be one that is not likely to meet with success, even temporarily, and it is clear that in the future we may expect the latter class to be completely absorbed in the former. Another argument that influenced the meeting at Rome was the supposed use of the astronomical day by sailors. Now, it appears that sailors never did use the astronomical day, which begins at the noon *following* the civil midnight of that date, but the nautical day which begins at the noon *preceding*, i. e., twenty-four hours before the astronomical day of the same date, ending when the latter begins. And the nautical day itself has long been given up by English and American sailors, who now use a sort of mongrel time-reckoning, employing civil time in the log-book and for ordinary purposes, while, in working up the observations on which the safe navigation of the ship depends, they are obliged to change civil into astronomical reckoning, altering the date where necessary, and interpreting their A. M. and P. M. by the light of nature. It says something for the common sense of our sailors that they are able to carry out every day without mistake this operation, which is considered so troublesome by some astronomers.

In this connection I may mention that the Board of Visitors of Greenwich Observatory have almost unanimously recommended that, in accordance with the resolution of the Washington Conference, the day in the English "Nautical Almanac" should be arranged from the year 1891 (the earliest practicable date) to begin at Greenwich midnight (so as to agree with civil reckoning, and remove this source of confusion for sailors), and that a committee appointed by them have drawn up the details of the changes necessary to give effect to this resolution without causing inconvenience to the mercantile marine.

The advantage of making the world day coincide with the Greenwich civil day is that the change of date at the commencement of a new day falls in the hours of the night throughout Europe, Africa, and Asia, and that it does not occur in the ordinary office-hours (10 A. M. to 4 P. M.) in any important country except New Zealand. In the United States and Canada the change of date would occur after four in the evening, and in Australia before ten in the morning. This arrangement would thus reduce the inconvenience to a minimum, as the part of the world in which the change of date would occur about the middle of the local day is almost entirely water, while on the opposite side we have the most populous continents.

The question for the future seems to be whether it will be found more troublesome to change the hours for labor, sleep, and meals once

for all in any particular place, or to be continually changing them in communications from place to place, whether by railway, telegraph, or telephone. When universal or world time is used for railways and telegraphs, it seems not unlikely that the public may find it more convenient to adopt it for all purposes. A business man who daily travels by rail, and constantly receives telegrams from all parts of the world, dated in universal time, would probably find it easier to learn once for all that local noon is represented by 17 hours U. T. and midnight by 5 hours (as would be the case in the Eastern States of North America), and that his office-hours are 15 hours to 21 hours U. T., than to be continually translating the universal time used for his telegrams into local time.

If this change were to come about, the terms noon and midnight would still preserve their present meaning with reference to local time, and the position of the sun in the sky, but they would cease to be inseparably associated with twelve o'clock.

The introduction of universal time would practically involve the adoption of the system of counting the hours in one series from 0 to 24, instead of in the two series 0 to 12 A. M. and P. M., for, as applied to universal time, the terms *ante-meridiem* and *post-meridiem* would be meaningless, except for places on the meridian of Greenwich. The use of the 24-hour system on railways and telegraphs would naturally assist in breaking the spell of habit which associates noon and midnight with twelve o'clock.

It may be mentioned that the Eastern and Eastern Extension Telegraph Companies already use the 24-hour system throughout their extensive lines of telegraph to avoid mistakes of A. M. and P. M., and to save telegraphing these unnecessary letters. In this connection the President of the Western Union Telegraph Company in the United States has stated that the adoption of the 24-hour mode of reckoning would, besides materially reducing the risk of error, save at least 150,000,000 letters annually on the lines of his company. It is also noteworthy that ninety-eight per cent of the railway managers in the United States, representing 60,000 miles of railway, have expressed themselves in favor of the adoption of the simple notation from 0 to 24 hours.

Considering that the only change which we are called on, in accordance with the Washington resolution, to make in our time-reckoning on railways is the adoption of the 24-hour system, it may be hoped that our railway companies will not be behind those of the United States in appreciating the simplification in railway time-tables which would result from this reform.

A BALD AND TOOTHLESS FUTURE.

By VIRGIL G. EATON.

TO a person who has a moderately well-supplied pocket-book and a thoughtful turn of mind, there can be no more fruitful theme for meditation than to go into our large halls, theatres, churches, and other places of public resort, and, securing a seat in the gallery or in the rear part of the room, look at the heads of the audience, for no other purpose than to ascertain by actual count how many show signs of baldness. Unless the experimenter has been in the habit of counting for this object, he will be surprised to learn that, in most of the Eastern cities, fully thirty per cent of the men over thirty years of age show unmistakable signs of baldness, while nearly twenty per cent have spots on their heads that are not only bald, but actually polished with the gloss that is supposed to belong to extreme old age alone. I have been in the majority of the churches and theatres in all the large Eastern cities, as well as in Chicago, St. Louis, and other places of the West, and have verified my assertion by actual count. From my observation I find that bald-headed men are most plentiful in New York and Boston. After these come Philadelphia, Washington, and the Western towns. I say "men," for two reasons: 1. Because women usually wear their hats or bonnets on such occasions, thus covering their crowns. 2. In case their hats are removed, the hair is combed up so as to cover any possible bald spot, or else there is an artificial "switch" to hide the defects of nature. So, without indulging in any speculations regarding what may be, I will confine myself to what is to be seen.

Here are a few observations taken in Boston. Trinity Church: 243 men; 71 actually bald, 46 indications of baldness. King's Chapel: 86 men; 38 actually bald, 14 indications of baldness. Hollis Street Theatre, orchestra at performance of the "Mikado": 63 men; 27 actually bald, 10 indications. Boston Theatre—Judic: 126 men; 51 actually bald, 43 indications.

These observations were taken from the more cultivated classes of society, and do not give a fair representation of the Boston head, as repeated calls at the dime museums and cheaper variety performances demonstrated. For instance, of the thirty men seen in the seats of the World's Museum in Washington Street, but eight were bald, while only five others had thin hair, showing that baldness was simply a question of a very few years. Again, of forty men at Austin and Stone's Museum, twenty-two had their heads well covered; and at the Windsor Theatre (variety) I found less than twenty-five per cent who had thin hair.

On the other hand, at shows and entertainments of more refine-

ment, the bald-headed element was considerably larger. Of two nights when Patti sang at the Boston Theatre there were forty-six per cent of bald heads on one occasion and forty-two on the other. When De Lussan appeared in "Fra Diavolo" I discovered thirty-eight per cent of baldness, and at one of Matthew Arnold's lectures there were forty-six per cent. In fact, out of hundreds of observations, extending over several years, I have found that the higher the price of admission, and presumably the more refining nature of the performance, the larger the per cent of bald heads. One night I counted the occupants of a few settees in my immediate vicinity at an exhibition which John L. Sullivan gave at the Mechanics' Fair Building, and was surprised to find that less than twelve per cent of the men were bald. As this was a show where the spectators had the privilege of retaining or discarding their hats at pleasure, I think it was not a fair test.

In large cities, where over one half of the population is under thirty years of age, and where half of those who attend places of amusement can safely be placed at less than forty years, these facts are certainly interesting to every person who wishes to know what kind of a looking person the coming man is going to be. It is not uncommon to see men under thirty years of age whose crowns are totally denuded of hair. In one store in New York city are twelve shipping-clerks, all under forty years of age, and seven of them are bald, while two more are vainly trying to prevent baldness by using hair-restorers. There are more bald-headed men in Boston than there are who have black or red hair. Next to the brown heads, the bald heads have the largest number of representatives. In order to prove this, it is only necessary to go to any party or place of amusement or assemblage of any kind in New England. In my capacity as newspaper reporter I attended a funeral in Beacon Street, Boston, a few years ago, where the clergyman, the undertaker, and every one of the mourners were bald-headed! The only perfect head of hair I saw at the house was that of the fair young girl who lay in the casket. Instances showing the proneness, not only of Boston and New England, but of the whole country, to become bald, could be given indefinitely, but I think the foregoing will suffice.

Now, in view of these facts, can any one say that the coming man, of New England at least, will not be bald? If not, what is the present generation doing, or what can it do, to hinder such a fate?

The old physiological law of stock-breeding, that "like begets like," applies to men as well as to animals. If men at the age when they marry and begin to raise children are bald-headed, they can expect their children to enjoy the traits of their sires. A father and mother who become bald when young can safely predict a like result for their offspring. There is no reason why bald heads should not yield to the laws of heredity as much as curly heads or red heads. Anything else would seem unnatural.

To hinder such a tendency it is only needful to learn its cause, which seems to be no other than wearing tightly fitting head-covering, living in-doors, and the lately developed habit of keeping the hair closely cropped. Among the savage races, who live out-doors most of the time and go bareheaded, baldness is unknown. To these hair is a protection. It grows in rank profusion without care. Something is needed to protect the scalp from sun and wind and rain, and hair grows luxuriantly; when hats and caps were invented they took the place of the natural shield, and the hair, having no longer any function to perform, fell away. The days of its usefulness in the economy of life are past, and, like the tails of the monkeys and the muscles of the ears, it has become rudimentary from disuse. If it is to be restored to its former glory, men must stop making "close crops," and must go bareheaded. That there are fewer bald-headed women than men is due to the fact that ladies do not "shingle" their hair after the manner of the sterner sex. The recent fashion of "banging" and "frizzing" their hair, adopted by ladies of fashion, is a death-blow to their sex having good hair much longer. If it continues, there will be as many bald-headed women as men. Allowing the hair to grow long and exposing the head to the weather with little or no protection are the methods by which a rapidly disappearing beauty of the race can be restored. It is to this neglect of fashionable care that the farmers with "hay-seed in their hair" owe their comparative freedom from baldness. The man or woman who wears a closely fitting cap and works in overheated shops and stores, under the rays of gas and electric lights, can not expect to have good hair. If they want to be "worth scalping" they must go out in the open air and expose their heads so that they will feel the need of scalp-locks. Nature never makes anything for which she has no need, and, when she finds that her works are of no use, she proceeds to eliminate the superfluous article.

The same rule can be applied to the early decay of human teeth, and with the same results. Old men now living tell of a time when dentists were almost unknown. The family physician used to keep a pair of forceps and tooth-keys to pull out such teeth as insisted on aching for an unreasonable length of time, while the idea of false teeth was so strange that the person who had a set was an object of curiosity for the whole neighborhood. Now, nearly half the people over twenty years of age have one or both jaws occupied by artificial teeth, and the sign of the dentist occupies a conspicuous place on every street corner.

When the men used to live largely on a meat diet, sometimes cooked, though oftener raw—tearing it off from the bones in great junks, and chewing it like beasts of prey—they had some use for canines and molars, and these implements were furnished to meet the demand. With the invention of knives and forks, of hashes and con-

centrated preparations, of bolted flour, and pies and cakes, came a time when the teeth had few offices to perform, and they began to decay for want of employment. To use a labor-phrase, they were "out of work."

The fact that father and mother have poor teeth descends to the children with even more surety than a deficiency of hair. Dentists inform me that fully one half of their youthful patrons never shed their "milk" molars. They remain in the jaws (or on them) until the possessor is from twenty to thirty years of age, and then decay and come out, or are pulled, to make room for "store" teeth. Owing to this habit, many a person who has a good-looking set of canines and incisors is without a single molar. Wisdom-teeth, that come at full maturity and mark the age of manhood and womanhood, are usually short-lived, and frequently show specks of decay as soon as they appear. Mankind do not use teeth, and so the teeth disappear.

Looking at the facts as presented, there can be but one conclusion regarding the coming man. If the present state of things continues, he will be bald-headed and toothless. From all indications, the time when this kind of a coming man will be here is but a few generations away.

LIFE ON A CORAL ISLAND.*

By Professor W. K. BROOKS.

AFTER the discovery of the Bahama Islands, Columbus writes to Queen Isabella that "this country as far surpasses all other lands in beauty as the day exceeds the night in brilliancy"; and as the scientific expedition of the Johns Hopkins University approached these islands, and the beauties of the land and sea and sky of the tropics began to unfold themselves before our eyes, all the members of our party echoed, in words of their own, the impression of the great explorer.

We had been shut up for nineteen days in a little schooner, smaller than those in which Columbus made his first voyage, in a hold which did not allow us to stand erect, with no floor except a few rough boards laid on the ballast of broken stone. We had found an endless source of pleasure and profit in the examination of the marine animals which drifted by us in the floating sargassum of the Gulf Stream, and we had seen for ourselves what we had so often read, that the ocean is the true home of animal life, and that the life of the land is as noth-

* This interesting sketch of what a party of enthusiastic working naturalists saw outside their laboratory, during a recent visit to the Bermudas, first appeared in the "Baltimore Sun." As it is well worthy a more permanent record than the columns of a daily newspaper can afford, we gladly reprint it from slips kindly sent us by the author. —The Editors.

ing when compared with the boundless wealth of living things in mid-ocean. Still, our three weeks of tossing and pitching in a heavy sea had tried our patience until we were heartily tired of our narrow quarters, and ready to give a warm welcome to any land.

We sighted Abaco, the outermost one of the Bahama Islands, at daybreak on a beautiful Sunday morning, and we were soon in calm water, threading our way before a gentle breeze, which hardly ruffled the surface among the countless small islands which form a fringe or natural breakwater around the "mainland" of Abaco.

This island, which lies nearly north and south, is about a hundred miles long, and its eastern edge is bordered by a narrow sound from three to five miles wide, the outer shore of which is formed by a rim made up of thousands of small islets, or "keys," separated from each other by narrow, winding channels. Some of the keys are ten or twelve miles around, while others are no larger than a small house. They are high and well wooded, with bold headlands and cliffs, and long, winding bays and inlets.

Our first sail among them was an experience which will always remain fresh in our memories. As far as the horizon, before and behind us, was a series of bold promontories, one jetting out beyond another, and, as our vessel rounded one rocky point after the other, new stretches of land and water opened before us with new glimpses of the strange country we had come so far to explore.

We had read many glowing descriptions of the gorgeous beauty of the tropics, but these were all forgotten, and we felt that we were entering a land where everything was new. Our reason refused to put any limit to the wonderful discoveries which filled our imagination, and, as we sailed slowly past cliffs bathed in spray from the breakers which rolled in from the ocean, past the mouths of caves which the sea had hollowed out in the limestone rock, past deep bays and long, winding sounds which penetrated deep into the islands, our fancy peopled every cave and tide-pool with strange animals new to science, and we felt all the glow of enthusiasm which we experienced when we first entered a scientific laboratory and prepared to solve all the problems of the unknown universe.

Navigation among the sunken reefs and submerged islands, which are much more numerous than those above water, is very dangerous. A few miles away the ocean is more than three miles deep, with no land nearer than Africa, and the heavy sea which is always pounding upon the outer reefs soon puts an end to any vessel which deviates from the narrow, winding channels between the ledges of growing coral; but our pilot steered us safely through the crooked inlet between Whale Key and No-Name Key into the inner sound.

Here we saw, for the first time, that intensely green sea which has been so frequently mentioned by voyagers among coral islands. This vivid color soon became more familiar, but never lost its novelty, and

it still holds its place as the most brilliant and characteristic feature of this highly colored landscape, and it is totally unlike anything which is to be seen anywhere except in a coral sea.

The water is so perfectly pure and clear that small objects, like shells and star-fish, are visible on the pure white coral sand at a depth of fifty or sixty feet, and the sunlight, which is reflected from the white bottom, gives to the water a vivid green luster, which is totally unlike anything in our familiar conception of water. The whole surface of the sound seemed to be illuminated by an intense green, phosphorescent light, and it looked more like the surface of a gigantic polished crystal of beryl than water. The sky was perfectly clear and cloudless, and overhead it was of a deep blue color ; but near the horizon the blue was so completely eclipsed by the vivid green of the water that the complementary color was brought out, and the blue was changed to a lurid pink as intense as that of a November sunset. The white foam which drifted by the vessel on the green water appeared as red as carmine, and I afterward found in a voyage through the sounds in a white schooner that the sides of the vessel seemed to have a thin coat of rose-colored paint when seen over the rail against the brilliant green.

About noon we reached our destination, Green Turtle, a small town on a key of the same name, nearly a hundred and fifty miles from Nassau, the center of the civilization of the islands. As there is no town between Green Turtle and Nassau, and as the only regular connection in the summer-time between Nassau and the rest of the world is a steamer once a month to New York, and as no message from home could reach us in time for a reply by the same steamer, we were more remote from our friends and families than we should have been in the Sandwich Islands. Although one member of our party had been a traveler in Asia and South America, and all but two had lived in Europe, I think that, as we came to anchor in the little harbor at Green Turtle and looked back upon our long journey, our scanty fare and narrow quarters, and thought of the miles of water which lay between us and home, we all felt that we had never before been so far away. As the strict laws of the island do not permit the transaction of any business on Sunday, we were not allowed to disembark until the next day, and we had plenty of time to examine from the water the new land which we had been so long in reaching.

We came to anchor in the mouth of a beautiful winding bay, in water about thirty feet deep, but so clear that the vessel seemed to float in air, and the motions of the gigantic star-fishes and sea-urchins could be studied on the white bottom as well as if they were in an aquarium. The shores of the bay are high and rocky and well wooded down to the water's edge, where the vegetation ends in a fringe of mangrove-bushes perched above the pure salt water on their long, stilt-like roots, which arch up from the bottom like the ribs of a great

umbrella to meet several feet above the water at the point from which the main stem arises. Behind us, several miles away, is the "mainland" of Abaco, separated from us by the green water of the sound, which stretches in both directions as far as the horizon. In front of us, on the shore of the bay, lies the town of Green Turtle, a much more prosperous and civilized place than we had been led to expect, with freshly painted two-story stone and frame houses, set side by side close to the straight, narrow main street, which is used only as a foot-path, as there are no horses or cattle nearer than Nassau. The main street, which is called Broadway, is hardly more than ten feet wide, while the cross-streets are just wide enough for two persons to pass. They are bordered by stone walls or high fences, and are perfectly level, as clean as the deck of a vessel, pure white, with a bed of solid coral limestone, the inequalities of which are filled with cement.

This description applies to only the better portions of the town, where the white natives and a very few of the negroes live. On one side of the harbor a long, low sand-spit separates this portion from the much more picturesque portion inhabited by the poorer people, most of whom are negroes. Here the little palm-thatched huts, without doors or windows or chimneys, most of them in the most attractive stages of picturesque decay and dilapidation, without any regular arrangement nestle in a thicket of aloe and cactus and bananas and castor-oil plant, which runs parallel to the white sand-beach, and is penetrated here and there by the narrow white foot-paths which lead to the huts.

This is by far the most distinctive and interesting portion of the town, and every feature of the landscape, the clear water, the white beach, the tropical thicket, the thatched huts, the towering cocoanut-trees, and the dark-green leaves of the bananas, are all so thoroughly tropical that, as we lie on the deck of the little schooner floating on the glassy surface of the calm water under the deep blue sky, with great banks of white clouds piled up on the horizon, we have before us every feature which our reading has led us to associate with coral islands, and it is easy to imagine ourselves in the South Pacific.

Our subsequent exploration of the Bahamas showed us that nowhere else in the whole group are so many of the characteristic peculiarities of the tropics crowded into such a small space. We had very scanty information when we made our selection, but the choice of Green Turtle was a fortunate accident, for our first view of the islands gave us a more intimate acquaintance with coral islands than we should have gained in a month spent at Nassau.

Beyond the town the island ends in a bold, overhanging cliff, separated by a narrow inlet from a small, low island, Pelican Key, which is covered by a growth of cocoanut-trees. From our anchorage we can look out through this inlet, framed between the two islands, and

can see the vivid green gradually fading as the water deepens toward the edge of the reef, which is marked by a line of white breakers, heaving and tossing as the swell rolls in from the deep blue water, which stretches beyond until it merges with the lighter blue of the cloudless sky.

Every outline is so sharply defined in the pure atmosphere, and so many elements are crowded into the brilliantly colored picture, that it is more like a landscape traced by fancy in the clouds at sunset than a substantial reality, and the whole is so much like fairy-land that we feel that if we should shut our eyes for a few minutes we should expect on opening them to find the picture dissolving into clouds.

Curbing our fancy, however, and returning to the solid facts about us, science tells us that the history of the country is far stranger than any fairy-story, and that, as the geologist measures time, this whole group of islands, stretching for six hundred miles across the map, and furnishing a home where thousands of people are born and pass their lives, and grow old and die, is actually as transient and unstable as a summer cloud. Only a few years ago, as years go with the geologist, every particle of the land before us was diffused through the ocean in invisible calcareous molecules, which have been gathered from the waves and deposited by microscopic animals, and everywhere about us we find abundant proofs that if these animals should cease their constructive labors the whole would soon be diffused through the ocean like the lump of sugar which is dissolved by our coffee.

After we had familiarized ourselves with this distant view, the custom-house officer came aboard and welcomed us to the islands in the name of the British Government, and told us that, although we could not be permitted to settle on shore until the next day, we were at liberty to land and explore.

All the members of our party will long remember the kind face of this gentleman, Mr. Bethel, with whom we soon became well acquainted. He is not only the custom-house collector, but also resident magistrate, postmaster, health-officer, superintendent of schools, and the general representative of the Government. I myself, as director of the party, was the only witness of the promptness and informality with which he dispatched our business at his office, but we all were made to feel that he is a warm and kindly friend, ready to be called upon at all times for help and advice, and pleased to welcome us at his home.

As soon as we received his permission to land, a party started off in the yawl, which we had brought from Baltimore on the deck of our little schooner, to visit an abandoned house which was pointed out to us upon a hill-side at a distance from the town.

The boat soon reached the mangroves, and, pushing in as far as possible, we found ourselves surrounded by the life of the tropics. As the tide was out, we could reach up from the boat and gather over our

heads the oysters which were growing in great clusters on the roots and branches of the trees. The clear water was filled with fishes of strange forms and brilliant colors, and they were perfectly fearless, so that they could be examined without difficulty, as they chased and captured their food among the submerged roots. The bottom was thickly covered with beautiful sea-anemones, and everywhere, on the bottom, on the roots and branches of the trees, and on the rocks at the water's edge, we found a wealth of mollusks and crustacea, which soon taught us to regard the mangrove-thickets as rich collecting-grounds. We were, however, unable to penetrate through it to the land until we discovered a little cove, where the bushes had been cut down. Pushing the boat into this, we reached an open, grassy landing-place, shaded by two or three cocoanut-trees, and surrounded by a dense forest except at one point, where a narrow path led up the hill to the house.

The front was at first a stronger attraction than the house, and one of the first objects to catch the eye was a great mass of epiphytic orchids on a dead branch close to our landing-place. The species is not one that is prized by orchid cultivators, but the plant, which was much more luxuriant than those which are seen in greenhouses, and in full bloom with flowers which diffused a delightful fragrance through the woods, was gathered just before our return to Baltimore, and was safely carried home, and is now here in full vigor and beauty, a living memento of our first landing on a coral island.

As we were unable to penetrate the thicket without great labor, the party soon made its way along the path up the hill to the old house, which was critically examined as to its fitness for a laboratory and home for our party of seven. It proved to be a one-story frame house, without windows or floor, but out-of-doors the surroundings were all that a naturalist could wish. The exposed side commanded a view of the island and harbor, while the other three sides were surrounded by a dense growth of shade and fruit trees, which had been planted by the absent owner. We also found a large stone cistern shaded by palms and tamarind-trees and orange-bushes, and filled with good water.

We had been informed that there were no vacant houses in the town, and, although this one was very small and not at all suitable for work with the microscope, a residence in this cool and elevated place in the heart of the forest seemed so attractive that the discovery that it swarmed with mosquitoes did not dampen our enthusiasm; and, even after the fine general view of the island, which we obtained from the hill behind it, had shown us that we were separated from the town and from the nearest house by a long, winding sound, and should be compelled to go three or four miles for our supplies, we still felt that the attractions of this retired spot would overbalance all the disadvantages in case no better house could be found in the town.

When the excursionists returned to the schooner, however, they

found that another member of the party, who had also been house-hunting, had found one in the town which was much better fitted for our use. The owner and occupant was willing to vacate and rent to us, but he could not talk business on Sunday. The next morning a satisfactory bargain was made, and after our business at the custom-house had been dispatched we took possession and prepared to land our apparatus and furniture. This work went on slowly, for our house is at some distance from the water, and, as there are no horses or carts, everything was carried up. We found labor very cheap, and, while our nickel cents and five-cent pieces are not regarded as money, a big copper cent is highly appreciated. The pastor of one of the churches kindly exchanged some of our silver money for a pocketful of them from the contribution-box, and a large force of natives was soon hired and set at work. They quickly picked out all the lighter and smaller packages, and a long procession of men and boys and girls was soon on its way to the house, marching like a column of ants along the narrow path from the landing, laden with tin buckets, chairs, nets, oars, and small bundles. The larger boxes required more deliberation, and after one or two journeys most of our assistants resolved themselves into advisory boards and escorts, and a procession was formed for each package, but nothing was lost or stolen or broken, and before night everything was in the house, our beds were set up, and our cooking utensils and provisions were unpacked. The only available stove in the town was rented and set up, a cook was hired, and we were able to rest and to examine our new house while waiting for our first meal on shore.

The house is small, but by using all the rooms as work-rooms, and putting our beds in corners which are of no other use, we have found room for all hands. It is a two-story house, with the walls of stone as far as the second floor, and of wood above, nicely painted and papered, in good repair, with plenty of doors and windows, a large stone cistern of good, cool water, and on the second floor a large veranda overhanging the street in front, for, like all the large houses, it is close to the street, which, as a sign on the corner informs us, is Union Street. It is a narrow pathway about five feet wide, of smooth white limestone.

We are near the corner of Broadway, and on one side of us all the houses are large, well built, and in good repair, with well-kept gardens. On the other side, the street gradually narrows down to an unfenced foot-path, which leads to the brush through a jungle of rank vegetation through which little thatched huts are irregularly scattered. We therefore have all the advantages and comforts of the better portion of the town, but, being on the border-line, we are sufficiently near the more primitive and interesting portion to establish a familar acquaintance with the people, and to get an inside view of their life. This we accomplish the better, as one of the members of our party, who is a

physician, finding that there is no other doctor within a hundred miles, kindly allows the people to call upon him for gratuitous service in his profession. In a few days, as his desire to help those who need him has become known, we are besieged at all hours by patients, who stand in the street and call out, "Is the pill-doctor at home?" He is now so fully employed that his own studies are seriously obstructed, and he has been forced to establish office-hours.

His usefulness is seriously impaired by the fact that a merchant to whom the poor people take their prescriptions to have them forwarded to the apothecary at Nassau is apt to suggest as a substitute a purchase from his stock of strengthening-plasters, or from an invoice of liver-pills which he imported some years ago.

I am surprised to learn from Dr. Mills that in this delightful climate, where the temperature is almost uniform throughout the year, and the thermometer seldom rises above 85° or falls below 80°, there are many cases of consumption. A death from this disease took place in one of the little huts near our house a few hours after our arrival.

We are much pleased that, although our home is close to the street, there is no building opposite, but a vacant lot, planted with cocoanut-trees and bananas, and surrounded by an open cast-iron railing, which does not obstruct our view, or cut off the cool sea-breeze which blows continuously.

Our first day on the island ended in a beautiful cloudless evening, with a gentle breeze and a full moon, and as we sat on our veranda and rested after our hard day's work, the sun set and in a few minutes the moon and stars were in full splendor, for we are so far south that the sun drops straight down, and we have no twilight. As we sat and listened to the mocking-birds, which were singing on all sides, and watched the long, graceful, fern-like plumes of the tall cocoanut-trees swaying against the clear sky in the breeze and reflecting the moonlight from their glossy surfaces, a feeling of perfect rest after our long voyage stole over us, and, while everything reminded us of the long miles of water between us and our friends in Baltimore, we felt almost at home in our new abode.

We watched the half-naked negro children at play in our street, and listened with great interest to wild music which came from one of the huts, and was, as we learned next day, the song of friends gathered at the bedside of our dying neighbor; and at last we ate our first meal of pineapples and bananas and sapodillas and fresh cocoanuts, and then turned in, happy in the thought that we could sleep without holding on, and delighted with our first experience of a coral island.

ARE BLACK AND WHITE COLORS?

By HARRY AUSTIN DOTY.

ALTHOUGH there is no general agreement as to whether black and white are or are not colors, it is very commonly held both by scientists and artists that they are not colors. Encyclopædias, dictionaries, and text-books usually class black and white separately from colors, defining the former as the absence of all color and the latter as the sum of all colors. Von Bezold ("Theory of Color," p. 41) says, "An object appears black if, in the light falling upon it, those species of rays are wanting which alone it is capable of reflecting"; and, again, "White and black . . . which, indeed, are not colors at all in the true sense of the word." But, on page 90 of the same work, the heading of paragraph 48 is "White is a mixed color"; and, again, on page 113 it is stated that "white and all the very pale colors which are closely allied to it must be counted among the cold colors." It is not meant to attach much importance to such little inconsistencies in this very excellent work, but simply to indicate an indecision regarding the limitation of the word color. For another instance may be quoted Field, an English artist, who says of black that the artist is bound to regard it as a color; that "it is colorless, but extinguished light"; that "to be perfect it must be neutral with respect to color and destitute of sheen or reflective power in regard to light," and that "there is no perfectly pure and transparent black pigment." And the same author regards white light as colorless. These latter quotations are not made to emphasize their obvious inaccuracies, but to further illustrate the absence of anything like a unanimity of opinion regarding the classification of black and white in the chromatic scale. Many other opinions might be quoted, showing not only an indecision on the particular point herein discussed, but also widely different ideas concerning the nature of black and white.

In endeavoring to answer the question propounded we can do little more than test the propriety of restricting the application of the word color to less than the entire range of visual impressions. It will be necessary first to inquire just what relation black and white have to other retinal impressions.

At the outset it should be noted that we have no retinal standard. An object may convey a color impression which varies in the same individual with the conditions of rest or fatigue of the eye, with the character of the prevailing illumination, and also according to the influence of neighboring bodies which may produce effects of contrast. There is often a temporary or permanent difference in the color-perception of the two eyes of the same person; and among persons there are of course still wider differences, even excluding abnormal

eyes from the comparison. It is easy to mix a paint which will be called black by one and gray by another, and with a little less illumination the most sensitive eye might detect no gray whatever in the mixture; and even among a number of pigments, all of which would be classed as undoubtedly black, one may by comparison see differences and be able to select some which are "blacker" than the rest. Crumple a piece of white paper, and it exhibits lights and shades of greatly different degrees, some of the shades perhaps being deep enough to be designated black, and all intermediate shades may exist, but any two persons would not be likely to agree upon exactly at what particular shade should be drawn the line between gray and black. The retinal impression, therefore, under ordinary circumstances is not a reliable guide to the classification of the cause which produces it.

Consider, then, how we get impressions of color from objects. The sun emits waves of light varying in length by infinitesimal gradations between the extreme red and the extreme violet of the solar spectrum. As far as our purpose is concerned, we may disregard the ultra-violet and ultra-red rays, which are without perceptible effect upon the retina. These luminous or visible rays, acting together, produce in the eye the impression of white; separately, the longest waves produce red; those a little shorter, orange, and so on to the shortest, which produce violet. Aubert calculated that there were at least one thousand distinguishable primary color-impressions to be obtained from the solar spectrum. These rays of various lengths falling upon the things about us are partly absorbed, partly reflected, the latter portion producing in the eye sensations of color. Nearly all of our color-sensations are produced by this "selective reflection," and it will be unnecessary here to consider the other causes of color-production. Reference will be made, however, to subjective color-impressions further on. Now it is very rare indeed, or never, that but one kind or length of waves is reflected by a pigment or surface; usually several kinds are present, and even surfaces having apparently a pure color not uncommonly reflect rays differing considerably in wave-length from those of the predominant kind. Or, to put it another way, the rays from a surface having a definite hue may find their representatives in the solar spectrum not only in the portion corresponding to that particular hue, but also in one or more remote parts of the spectrum. For instance, the light from green leaves contains not only, in predominance, green rays, but some red rays and some violet rays, which find their representatives in the middle and each end of the spectrum respectively. It is true, further, that almost every hue in nature or art is made up not only of several kinds of rays, but of all kinds found in the spectrum; that is, *some white light is almost always present in that which we receive from illuminated surfaces.*

Now, if blackness were the complete absence of light, the question

as far as it is concerned would be much simplified; but I shall endeavor to show that black is not a negative impression. All black pigments and materials reflect light, and many of them to an extent which makes the fact readily demonstrable. Compare under a bright illumination half a dozen black things to be found in any home—cloths, book-covers, etc.—and it will be seen on a more or less close examination that they are not identical in appearance. Color-makers have their blacks of various intensities and shades. One of the commonest of blacks, lampblack, in comparison with some others, appears a very obvious gray. These black surfaces and pigments can not all be devoid of reflecting power, as they would then be incapable of making any impression upon the retina, and the differences must therefore be due to the various amounts or kinds of light which they reflect. Moreover, *light reflected by black pigments is white light;* that is, they reflect all the different kinds of rays in sunlight. Professor Rood ("Text-Book of Color") found that the black pigments used in his experiments reflected from two to six per cent as much white light as white paper (which, itself, reflects about forty per cent of the light falling upon it), the light being the same in kind and quantity as that from white paper under a sufficiently feeble illumination. There are, it is true, small differences in black pigments in power of reflecting the various components of white light. Blue may be slightly in excess of the normal proportion in white light, and so on, but these are so trifling that they do not affect the question before us. A black pigment with no reflecting power seems to be unknown, and is probably an impossibility. And it is by no means certain that absolute darkness should be taken as a standard of blackness, for several reasons. The impossibility of reaching the standard in practice and of making comparisons in perfect darkness would render it valueless. But the most important objection to it is this: after the retina has ceased to be affected by light, there become manifest certain subjective impressions, perhaps caused by circulation of the blood in the retina, which are not at all suggestive of black;* in fact, a very black pigment appears to the writer much "blacker" than the darkness of a closet. The influence of contrast, which is of course impossible in perfect darkness, seems to be necessary to the impression of the most intense black. An utter absence of retinal excitement would, of course, be no sensation at all, and would be of no more use as a standard of blackness than is the blind spot of the eye, of which we

* With the writer these subjective images often take the form of a circular, or irregular, greenish ring closing in or contracting over a violet background near the center of the apparent field of view, other similar rings succeeding each other in the same way at pretty regular intervals. Although having no bearing upon the subject, it might be added that these images, with others of a similar character, may always be observed in darkness after retiring; and I have a number of times thought I had detected, during the moments between waking and dreaming, a merging of these images, with exaggerations and mental accompaniments, into dreams.

are unconscious until we find by experiment that it is capable of intercepting a retinal image. It seems legitimate, therefore, that black, which, as far as we know it, is but a feeble white, should be classed with other sensations produced by light.

Inasmuch as black is nothing more than white very greatly reduced in intensity, if we can show that white is entitled to rank as a color, evidently black also should be similarly ranked. But with white the case is somewhat different from that of black, in that we have a recognized standard of white light, viz., the sum of the rays in the solar spectrum. These, as already stated, acting in concert upon the retina, produce the impression which we call white. The fact, however, that white light is composite, affords no reason for placing it without the scale of colors, for as far as the sensation produced by it is concerned it is quite as simple as red or green, and no eye is able to analyze it into its components. On the contrary, the sensation of white is brought into close relation with many colors because, like them, it may be produced by various mixtures of less than all kinds of rays. According to Rood, the following pairs of spectrum colors when combined produce a white which is indistinguishable from complete sunlight : red and green-blue, orange and cyanogen-blue, yellow and ultramarine-blue, greenish yellow and violet, green and purple. Groups of three or more kinds of rays may also produce a white, and these white mixtures seem to differ in no essential respect from such other mixtures as yellow and red, which make orange, or red and violet, which make purple. That all of the solar rays produce together white seems to be simply an accident of the retinal constitution ; for it is quite conceivable, and consistent with the color theory of Young and Helmholtz, that an eye might be so constituted that the combined effect of the solar rays might be, for instance, blue, while pairs of colors similar to those mentioned might still produce white ; and under these circumstances white would probably be called a color and blue would be the standard. Something of this kind does take place under artificial illumination. By gas or oil light, which are both very yellow compared with sunlight, a piece of paper which in sunlight is white would still be looked upon as white, although we know perfectly well that the light it sends to the eye is yellow in hue. The white of daylight appears blue by gaslight. On the other hand, objects which are yellow in daylight we are apt to believe white by gaslight, as they appear of the same hue as white paper seen under the latter light. These illusions are explained by the fact that the prevalent illumination is always regarded as white, no matter what hue it has referred to the standard of sunlight. White paper reflects equally well all the rays falling upon it, and, artificial light having an excess of yellow rays, the paper is really yellow in that light ; a yellow object has the property of reflecting principally yellow light, which it exercises in gaslight the same as in sunlight, and

it also is yellow under the former illumination; the white paper and yellow object, therefore, appear of the same hue; but knowing the paper to be white, and through an error of judgment accepting the prevailing illumination as white, the yellow object appears of this color. In view of these facts, it would seem that deductions drawn from the composition of white light are in favor of making it one of the colors. As supporting this view of the matter, might be mentioned Langley's investigations which have shown that the true color of sunlight, before some of its constituents have been filtered out by the atmosphere, is decidedly blue; and that, according to Brücke, ordinary daylight is slightly reddish in tint. It might be claimed as a reason for excluding white from the color series that it has no representative in the solar spectrum, but there is equal reason for excluding purple, unquestionably a color, which has no type in any part of the spectrum, being produced only by a mixture of rays from the red and violet portions of the spectrum. And it has been proved by several observers that all of the spectrum colors when increased in intensity tend toward white, and if made dazzling actually become white. Accepting this fact in a liberal sense, it is plain that white has a representative in every part of the spectrum; and this tendency toward white with increasing illumination being also a property of black, we have a direct argument for the inclusion of the latter with the colors.

In conclusion, it may be urged that the adoption of white and black into the chromatic scale is desirable for the sake of simplicity and uniformity in the nomenclature of this subject.

THE PHILOSOPHY OF DIET.

By a Layman.

IN the years to come it will be debated whether the great minds of the later Victorian era were most concerned with their souls or with their stomachs. Politics we may put by; they are always with us; but politics apart, between these two interests, the spiritual and the peptical, the question of precedence must surely lie. What other claimant can there be? Not literature, thrust away into corners, or tricked out in a newspaper like some May-day mummer; not art, divorced, in Carlyle's phrase, from sense and the reality of things; not music, crushed Tarpeia-wise under foreign gewgaws, or brayed in a chemist's mortar; not the drama, leveled to a tawdry platform for the individual's vanity. Not these, nor any one of these things; but the soul and the stomach, irreligion and indigestion, doubt and dyspepsia—call them what you will—these are the cardinal notes of our great inquiring age.

The former I will not touch. Sir Henry Thompson, indeed, asserts

a wise and orderly method of eating to be a religious duty, and, though the phrase might not quite pass muster in Exeter Hall, in some sense it assuredly is so. In this wise, then, I may profess to be in touch with religion, but in no other. Questions of faith and unfaith (as the fashionable jargon has it) I have neither the ability nor the wish to discuss. It were perhaps no bad thing for the happiness of the future if the wish were as generally wanting to-day as the ability. But on the interior economy of the human frame every man has a right to his opinion. Like faith this, too, it may be said, must take its stand mainly on the evidence of things not seen ; but the evidence, at least, in this case, is of a more certain and palpable nature. By what measure and system of nourishment the bodily and mental powers may best be encouraged and preserved, it is every man's duty to discover for himself. If he has any word to say thereon it is, if not his duty, at least his privilege to say it. This is one of the few points of human interest on which every man has a right to say what he thinks, and no man has a right to knock him down for saying it—provided always, of course, that what he says is based strictly on his own experience and limited strictly to his own concerns. In this one instance only, no man has the right to do unto his neighbor as he would do unto himself.

Sir Henry Thompson thinks that our forefathers did not sufficiently consider this great subject. Like Mr. Squeers, they have been, he admits, very particular of our morals. He sees a wise and lofty purpose in the laws they have framed for the regulation of human conduct and the satisfaction of the natural cravings of religious emotions. But those other cravings equally common to human nature, those grosser emotions, cravings of the physical body, they have disregarded. "No doubt," he says, "there has long been some practical acknowledgment, on the part of a few educated persons, of the simple fact that a man's temper, and consequently most of his actions, depend upon such an alternative as whether he habitually digests well or ill ; whether the meals which he eats are properly converted into healthy material, suitable for the ceaseless work of building up both muscle and brain ; or whether unhealthy products constantly pollute the course of nutritive supply. But the truth of that fact has never been generally admitted to an extent at all comparable with its exceeding importance." Herein were our ancestors unwise. The relation between food and virtue Sir Henry maintains (as did Pythagoras before him) to be a very close relation. His view of this relationship is not the view of Pythagoras, who, as Malvolio knew, bade man not to kill so much as a woodcock lest haply he might dispossess the soul of his grandam. Plutarch also was averse to a too solid diet, for the reason that it does "very much oppress" those who indulge therein, and is apt to leave behind "malignant relics." Sir Henry, in his turn, would not have men to be great eaters of beef, though he holds with Plutarch rather than with Pythagoras, being (so far as I can judge)

no believer in the doctrine of metempsychosis. But on the influence man's diet has on his conduct no less than his constitution he is very sure: "It is certain that an adequate practical recognition of the value of proper food to the individual in maintaining a high standard of health, in prolonging healthy life (the prolongation of unhealthy life being small gain either to the individual or to the community), and thus largely promoting cheerful temper, prevalent good-nature, and improved moral tone, would achieve almost a revolution in the habits of a large part of the community." *

Sir Henry is, perhaps, a little hard upon our forefathers. They thought more on these things, and had a clearer view of them, than he allows. A glance at the voluminous pages of Burton (author of "The Anatomy of Melancholy," not the gentleman who has done his best to spoil the "Arabian Nights" for us); a glance at this book, I say, might have shown Sir Henry how much the ancients thought and wrote—and how wisely too—on the stomachic influence. And always through the years wise men who studied the character and conduct of their kind have commended moderation in gratifying the appetite, and lashed indulgence. Milton, for instance, in a famous passage, has chanted in his solemn music the praises of a sleep which

> "Was aery light from pure digestion bred";

and Pope, in coarser strains, but with equal truth, reminded his fellows

> "On morning wings how active springs the mind
> That leaves the load of yesterday behind!"

A little thought will bring a hundred such passages to the memory.

But their way of thinking was not ours. They spoke generally, and left "the mean, peddling details" alone. "Be not unsatiable in any dainty thing, nor too greedy upon meats, for excess of meats bringeth sickness, and surfeiting will turn into choler. By surfeiting have many perished, but he that taketh heed prolongeth life." That was the text and bearing of their sermons. They did not believe in a written law for regulating these things. Tiberius, says Tacitus, held that man a fool who at the age of thirty years needed another to tell him what was best to eat, drink, and avoid ("*Ridere solebat eos, qui post tricesimum ætatis annum ad cognoscenda corpori suo noxia vel utilia alicujus consilii indigerent*"). It may be remembered, by those who think with Ensign Northerton, that Mr. Sponge (who knew more of Mogg than Tacitus) said pretty much the same thing to Mr. Jogglebury Crowdy, when the latter's unseemly want of that knowledge had helped to spoil a day's hunting. And between Tiberius and Mr. Sponge comes a host of authorities, all harping on the same string. "There is," says Bacon, "a wisdom in this beyond the rules of physic: a man's own observation, what he finds good of, and what he finds hurt of, is the best physic to preserve health." The melancholy

* "Food and Feeding," by Sir Henry Thompson, F. R. C. S., etc., third edition, 1884.

Burton concludes that "our own experience is the best physician; that diet which is most propitious to one is often pernicious to another. Such is the variety of palates, humors, and temperatures, let every man observe and be a law unto himself."

Sir Henry has made elsewhere * some pertinent quotations from a certain Italian work, of some fame in its day, "Discorsi della Vita Sobria," written by Signor Luigi Cornaro. This amiable old gentleman, a native of Padua, addressed himself at the ripe age of eighty-three to give the world assurance how much a sober life could do. He repeated the assurance at ninety-five, and subsequently passed away, "without any agony, sitting in an elbow-chair, being above a hundred years old." An English translation of his Discourse was published in 1768, and from this Sir Henry has made his extracts. But an earlier translation, the work of George Herbert, was published at Cambridge in 1634, in a curious little volume with a very long title, "Hygiasticon, or the Right Course of preserving Life and Health unto Extreme Old Age, together with Soundness and Integrity of the Senses, Judgment, and Memory." This is really the title of the first essay in the book, originally written in Latin by one Leonard Lessius, a divine who has anticipated Sir Henry in the theory of the religious duty. "The consideration of this business," he says, as an excuse for handling such temporal concerns, "is not altogether physical, but in great part appertains to divinity and moral philosophy." Dr. Lessius holds both with Bacon and Burton in their opinion of the value of personal experience, but he treats the doctors somewhat cavalierly. "Many authors," thus his essay opens, "have written largely and very learnedly touching the preservation of health: but they charge men with so many rules, and exact so much observation and caution about the quality and quantity of meats and drinks, about air, sleep, exercise, seasons of the year, purgations, blood-letting and the like, . . . as bring men into a labyrinth of care in the observation, and unto perfect slavery in the endeavoring to perform what they do in this matter enjoin." Bacon does his spiriting rather more delicately: "Physicians are some of them so pleasing and conformable to the humor of the patient, as they press not the true cure of the disease; and some others are so regular in proceeding according to art for the disease, as they respect not sufficiently the condition of the patient."

It is clear that with the wise men of old quantity rather than quality was the ruling law; not what a man ate, but how much he ate was the capital thing for him to consider. A tolerably simple diet is advised, though the wise Lessius holds that the quality of the food matters little, so that the man be healthy; but whatever it be, let there be moderation; measure is the one thing needful. The difficulty of finding this measure is confessed: "Lust knows not," says St. Augustine, "where necessity ends." By the time he had reached his thirty-

* "Diet in Relation to Age and Activity," London, 1886.

sixth year Cornaro had accustomed himself to a daily measure of twelve ounces of food and fourteen of drink—which does not, I own, convey a very exact notion to me, though I take it we Gargantuans should find the measure small. He does not seem to have been particular what he ate, and he did not shun wine. "I chose that wine," he says, "which fitted my stomach and in such measure as easily might be digested." He found it no labor to write immediately after meals. On the contrary, his spirits were then so brisk that he had to sing a song to get rid of his superfluous energies before sitting down to his desk. Lessius is loath to commit himself to any certain scale: "If thou dost usually take so much food at meals as thou art thereby made unfit for the duties and offices belonging to the mind, . . . it is then evident that thou dost exceed the measure which thou oughtest to hold." He tells, on ancient authority, some marvelous tales of the little men have found enough to keep body and soul together: how one throve through a long life on milk alone, how another lived for twenty years on cheese. In monasteries and in the universities this desired measure is, he says, more easily to be found, for there either the statutes of the societies, or the "discreet orders of the superiors" have ordained the quantities of wine and beer that are fit to be drunk. Of monasteries I have no experience, but in the universities I have been given to understand that it is (or was, for the old order changes now so fast that it is hard to say what a day may not bring forth) the custom to leave such matters mainly to the discreetness of the students—which, it may be, is like Goethe's poetry, not always inevitable enough. On the whole, Lessius seems to incline to Cornaro's allowance as sufficient, and perhaps as good an average as it is possible to strike. But he insists, as do all these antique sages, that the measure must vary with the age, condition, and business of the man. No hard and fast rule can there be. The golden mean must vary in all sorts of people, "according to the diversity of complexions in sundry persons, and of youth and strength in the selfsame body." And again: "A greater measure is requisite to him that is occupied in bodily labor and continually exercising the faculties of the body than to him that is altogether in studies." On this point all are agreed; on this and, I am sorry to say, on one other: *qui medice vivit, misere vivit,* "it is a miserable life to live after the physician's forescript."

It will, then, be seen that our forefathers were by no means so negligent of this thing as Sir Henry Thompson fancies. If they were not so minute and curious as we now are, they took at least a broad and liberal view, and surely a most wise one. It is, indeed, his general acceptance of this view which gives Sir Henry's utterances more value than those some of his brethren have put forth. "In matters of diet," run his wise words, "many persons have individual peculiarities; and while certain fixed principles exist as absolutely cardinal in the detail of their application to each man's wants, an infinity of stomach eccen-

tricities is to be reckoned on. The old proverb expresses the fact strongly but truly, 'What is one man's meat is another man's poison.' Yet nothing is more common—and one rarely leaves a social dinner-table without observing it—than to hear some good-natured person recommending to his neighbor, with a confidence rarely found except in alliance with profound ignorance of the matter in hand, some special form of food, or drink, or system of diet, solely because the adviser happens to have found it useful to himself." It is not only the good-natured companion of the dinner-table who errs this way. He were an ungrateful churl who would willingly say a harsh word about our ministers of the interior, so sympathetic, so patient, so courteous, so generous! Yet it must be owned that they are, some of them, a little apt to leave out of sight the varieties of the human constitution, to take all human stomachs as framed on one fixed primordial pattern; above all are they, as old Lessius complained, too likely to "bring men into a labyrinth of care in the observation, and unto perfect slavery in the endeavoring to perform what they do in this matter enjoin." Sometimes I think they do but flatter the weakness of humanity, and when they meet salute each other as the old augurs used. There are folk who will not so much as take a pill at their own venture, and never fulfill an invitation to dinner without a visit to the doctor next morning. He can not afford to drive such inquisitive fools from his door; and so it may be that the healing hand, like the dyer's, becomes subdued to what it works in. The answer given by his physician to Falstaff, on his page's authority, is one it were hardly wise to risk to-day.

I have tried to show that our old forefathers were not so careless of their peptics as has been thought. Yet there was a later time when they were sadly reckless in such matters, and possibly the chronic dyspepsia from which our race seems to suffer to-day may be the heritage of that recklessness. "The fathers have eaten sour grapes, and the children's teeth are set on edge." Certainly our stomachs are more bounded than was Wolsey's. To read the domestic annals of the close of the last and the early years of this century brings back the Homeric tales of the strength and prowess of the heroes who warred on the plains of Troy. No man of these degenerate days could do the work our fathers did, who "gloried and drank deep" like those lusty Jamschyds. They had, to be sure, some few points in their favor that we lack. They did not need—at least they did not use—those intermittent aids to the agreeableness of life that we seem to find so necessary. There were no brandies-and-sodas, no sherries-and-bitters, no five-o'clock teas; they were content with one solid meal in the day, and they did not put that off till it was growing time to begin to think about bed. And, I suspect, the most important point of all, they took life less hastily—not less seriously, but less hastily. Their brains were not always at high pressure; they did not

fritter away their minds and tempers on an infinity of pursuits, pursuits of business and pursuits of pleasure. If they did not all attain Wordsworth's "sweet calm" or the "wide and luminous view" of Goethe, at least they did not insist on barring the way to those blessed goals. This hasty life of ours, these successive shocks of change and alarm, this want of rest and leisure, all act or tend to act injuriously on the stomach, and thence on the brain. It is not only our unwise diet which afflicts the race with those "dolorous pains in the epigastrium," which one very learned lecturer on the philosophy of food asserts to be the note of this age—and which I take to be a glorified form of the homely stomach-ache.

I suspect, too, tobacco may have something to say to it. Not that I would say a word against that "plant divine of rarest virtue" for those who can use it, being indeed myself a feeble unit of the society of "blest tobacco-boys." An ingenious seeker after truth not long ago published the result of his research into the effect of tobacco and strong drink on the studious brain. It was a curious book, extremely amusing, and not all so foolish as might be supposed. But some random utterances there were, and none so random as those of one abstemious student (nameless, if I remember right, but the style was much the later style of Mr. Ruskin) who violently denounced tobacco as a general curse, and refused it all virtues, on the ground that the great men of old did very well without it. "Homer sang his deathless song," so wrote this fearful man; "Raphael painted his glorious Madonnas, Luther preached, Guttenberg printed, Columbus discovered a new world, before tobacco was heard of. No rations of tobacco were served out to the heroes of Thermopylæ; no cigar strung up the nerves of Socrates." Why, truly; and Agamemnon—I speak, of course, under correction of Doctor Schliemann—Agamemnon, I say, knew not the name of Cockle, and Ulysses had never heard of the lively and refreshing invention of the ingenious Mr. Eno; yet who will reason from that old-world ignorance that we might grow wise as Ulysses and brave as Agamemnon if we put away these artificial stimulants? Nay, if it comes to that, have not some fine things too been done since tobacco was introduced? But we need not take this modern counter-blast too seriously. Probably men of sedentary habits who smoke much are very moderate drinkers. He who takes tobacco because he likes the flavor, and finds the use refreshing and soothing, is not likely to take wine or other strong drinks in any quantity. I do not mean that he will not consume them together; that no man capable of appreciating either will ever do. How sad soever be the errors we have fallen into, at least we no longer share Madame Purganti's confusion of mistaking tobacco for a "concomitant of claret." But the virtue of each—I am not thinking of those who use them merely from habit, or because others do, or for a purely sensual pleasure—the virtue of each is, I fancy, a little marred by an adherence to

both. And where the question is not one of virtue, but of sheer fancy or gratification of the appetite, even he who can afford to indulge those delights will be wise to make a choice. At the time I speak of there was not much smoking. Cigars were not much in fashion; the pestilent heresy of the cigarette was not yet dreamed of; the sober pipe was mostly used, generally in that form known as a "long clay," and taken sedately after work was over, as a wholesome aid to reflection. No doubt there were exceptions, men who fuddled themselves over pipes and spirits, or beer; but broadly speaking the use of tobacco then was the exception rather than the rule, certainly among the upper classes of society, and both stomach and brain were thus better able to support the tax laid upon them.

The whole duty of man in this matter lies, as the wise Greeks saw it lay in all matters, in moderation. It is hard to believe that if a man be in a healthy state he need seriously vex his soul on the quantity of starch in his potato, or the relative proportions of hydro-carbons or carbo-hydrates necessary to a perfect diet. If he finds boiled meat more to his taste than roast, white more than brown, if whisky suit him better than brandy, or wine better than either, I can not think it necessary that he should go about very painfully to divorce himself from his liking. And if he finds water most palatable of all beverages, in Pindar's name let him gratify his taste, if he can do so in safety from those numerous and nameless diseases that we are told lurk in the pure element. Let him only be moderate in all things—in water as in the rest, for I take it, to swallow inordinate quantities of water, cold, or after the latest fashion, hot, can be no more wholesome to the human stomach than excessive doses of a stronger drink.

I am thinking of those whose habits must be chiefly sedentary, of those who have to work for their livelihood, to earn it by the perpetual exercise of their brain. And in our time, when once the golden term of youth is passed, these men form by far the most part of the community; men to whom the power of work is life itself—happy are they if it mean only their own life—and who must watch that power as jealously as ever fabled miser watched his gold. What they should eat and drink, and whether they should smoke, sure am I that they, and only they, can decide. Probably they will find that a fixed, unswerving rule is not the best, but that, as Bacon says, "The great precept of health and lasting is that a man do vary and interchange contraries." For myself I find that when living—existing rather, I would say—in London, a stimulating diet is more necessary than when I work in the fresh air and quiet of the country. A moderate amount of wine seems to me needful to balance the impure atmosphere of our great Babylon, to keep body and mind to the mark, jaded as they are by the unending din and bustle of human life. But the fresh breezes, the spacious air, the sunlight, all the beauty and the rest of the coun-

try, fill both body and brain with a strength that needs no artificial spur, and that can be used without tiring. I speak, of course, only for myself; many hard workers, wise workers, think otherwise; to many, very many, life must be lived in London, that wonderful wilderness of crowded humanity, and what it, and it only, can give is a necessity of existence that neither prudence nor fancy may interfere with. There are others, too, who profess themselves to be, and no doubt are, never so well, so attuned for hard work, as when cabined mid the bricks and mortar of London. Here, again, as in the other case, let each man be a law unto himself.

One other word I should like to say on the point of exercise. "You do not take enough exercise" is the common reproach made to the complaining patient; and forthwith off he rushes, to bring into sudden play muscles long disused and limbs that have forgot their cunning, till he finds to his angry astonishment that tired, not refreshed, and aching in every joint and bone, he has but made himself more incapable of work than he was before. No doubt the longer a man can keep up youth's standard of violent delights the better for him; but few men can do that with impunity, still fewer can go back to it when once the touch has been lost; the attempt is generally as dangerous as it is ridiculous. For myself I frankly own that I do not believe that hard exercise of the body is compatible with hard exercise of the brain. Nothing, I am firmly persuaded, brings a man to the end of his tether so soon. The exercise the brain-worker needs is the exercise that rests, not that fatigues. He needs to lull, to soothe his brain; and this he will do best in the fresh air, by quiet, and the gentle employment of the limbs and muscles that have been idle while he worked. It is this need, as it seems to me, that tells most strongly against London. What rest and refreshment is there for him who after a hard spell of work at his desk or in his studio, when

"All things that love the sun are out-of-doors,"

goes out into the noisy, crowded, reeking street? No rest comes to him from any beautiful sight, no rest from any beautiful sound; the air is no fresher than that he has left. Everywhere is a distracting sense of hurry, of the fever and the fret of existence. Like the weary Titan "with labor-dimmed eyes" and ears, alas! not deaf, he goes staggering on to a goal that daily grows more certain and more near. But here, again, I speak only of my own experience, which I would not for the world essay to make the wisdom of others.

In all these things, then, I believe a man must be his best physician. And, beyond the reasons mentioned, he must be so because only he can know what system it is possible for him to follow. Go abroad, says one doctor; get a horse and ride, says another; put your work away and take a thorough holiday, preaches a third. Golden counsel! but, alas, wind-dispersed and vain to so many of us! How

shall those obey it to whom the daily bread comes only with the daily toil, and how many of these there are among it the rich, idle world never dreams!

"... The fear that kills;
And hope that is unwilling to be fed;
Cold, pain, and labor, and all fleshly ills
And mighty poets in their misery dead."

That is the life's experience of many and many a man who bears a cheerful front enough to his fellows. While he has health and strength, while the sun is still in the heavens, he can bear the burden, uncomplaining if unresting. But as the day wears on, and the shadows grow, the question of the future grows with them, What shall be his fate when hand and brain can work no more? Happy as he may be in his work now, contented, prosperous, never can he wholly put by the thought,

"But there may come another day to me—
Solitude, pain of heart, distress, and poverty."

Such a one can put off that hour by no holiday pastimes which to the idle man of pleasure are a mere weariness of the flesh. But he can, so far as human will avails, put it off by hoarding his strength and health; and this he will most surely do by the observance of one simple rule, framed for man's conduct thousands of years before our wisdom discovered that the pancreatic juice converts starch into sugar, and that levulose is isomeric with glucose—the simple rule of moderation.—*Macmillan's Magazine.*

GERMAN PALEONTOLOGICAL MUSEUMS.

By ALBERT GAUDRY.

THE Germans have many excellent paleontological museums, in which the fossil records of the ancient history of their country are preserved and arranged in regular and proper order. Each of these museums, besides its general character, is distinguished by special features illustrating the more salient peculiarities of the local geology.

Besides its general museum, in which are collected the products of different countries, Stuttgart possesses a geological and paleontological hall devoted especially to the fossils of Würtemberg. This local collection, under the direction of Professor Oscar Fraas, is justly held in high repute, because in it can be followed from age to age the paleontological history of one of those countries in Europe which have been best studied. Here are especially to be seen those wonderful reptiles that lived on the continents during the Triassic epoch: the tosaurus, the zeuglodon, the mastodonsaurus and the metopias, permit

us to form some kind of an idea of the curious appearance of the fauna of that epoch. The Stuttgart Museum is also one of those in which the lias is best represented; and it contains the Holzmaden collection, which is celebrated for its entire skeletons of reptiles. M. Fraas had the kindness a few years ago to conduct me to the locality of the fossils and show me the condition in which they were discovered. They were generally incrusted by the rock, and only bulges were perceptible, which taught nothing to the untrained eye. But my guide was able to divine where the head, the limbs, and the tail could be found, and could even tell me what kind of an animal was concealed in the stone. Those complete skeletons which adorn many museums are brought out by the skillful use of engravers' tools. The Stuttgart collection contains several icthyosauri with their young within their bellies. As a rule, the head is turned toward the anus, as with other vivipares; but I saw one fossil containing two young turned toward the head, and another that had six, turned in as many directions. Is it supposable that the icthyosaurus had sometimes one young one, like the salamander, and sometimes several, like the viper and the slow-worm?

Munich has several important collections under the care of Professor Zittel; that of ammonites, for instance, which is said to be the most complete in existence, and the series of admirable preparations of fossil sponges, the skeletons of which M. Zittel has isolated by steeping them in acidulated water. I was pleased to see there the Pikermi fossils which Wagner first made known. But the principal curiosity of the Paleontological Museum of Munich is the collection of lithographic stones from the oölite of Solenhofen. If we have to go to Stuttgart to study the trias and the lias, it is to Munich we must go to admire the oölite. All geologists are aware that the Solenhofen stones were originally mud deposited on a shore where the inhabitants of the sea and of the continent met. In this mud the most diverse and most delicate beings of the oölite have been preserved with a wonderful perfection. There are to be found in it acalephs, a multitude of crustaceans, insects that have preserved the reticulations of their wings, their feet, and their antennæ, and ammonites with their aptychus, and fishes in course of transition from the ganoid to the teleostean state. Here especially we come to study flying reptiles. They present themselves in all positions. We can see here also the little compsognathus which, long before the discovery of entire iguanodons in Belgium, enabled us to understand the gait of those dinosaurians. The paleontologist might dream, while contemplating this collection of beings, that he could imagine himself in the midst of the secondary period almost as much as if it were still with us; and after seeing it we may readily believe that the day will come when our successors shall have a clear idea of the grand history of past ages.

Vienna, which has long been famous for its life and gayety, has

become a splendid city, with its fortifications replaced by spacious boulevards, adorned with gardens, handsome houses, and palaces. Science is destined to profit largely by these transformations. On one side of the Hôtel de Ville has been built the elegant Parliament-House, and on the other side, as a pendant to it, the Palace of the University. A little way from the Parliament-House, opposite the Imperial Palace, have recently been completed the Museum of Fine Arts and the Museum of Natural History. The University and the Natural History Museum are thus in the finest quarter of the city.

The University building is nearly finished. It is a pleasure to be a student in such a palace. Professor Suess, an eminent *savant* and a member of Parliament, directs the geological collections; and another professor, not less accomplished, Professor Neumayr, the paleontological cabinets. The Museum of Natural History belongs to the court (*Hof Naturalien Museum*). The emperor has just put at its head M. de Hauer, who wasformerly director of the Geological Institute. M. Fuchs is charged especially with the department of paleontology. I was told that the fossils would be separated from living species, as they were in the old museum, and that they would occupy six halls. The Hall of Vertebrates is adorned with mural paintings representing the landscapes of the different geological epochs, with their most characteristic animals and plants. These pictures are separated from one another by statues which have paleontological attributes. One figure holds an icthyosaurus, another the head of a dinotherium, another a part of *Cervus megaceros*, another the head of a *unitatherium*, etc. I only saw a few of the fossils, for they were all disarranged; but, among those which M. Fuchs was able to show me, I remarked skeletons of *Ursus spelœus*, a skeleton of *Megaceros*, and one of the quaternary goat, five specimens of the mastodon and dinotherium, and a series of vertebrates from Maragha in Persia, of the same age as those of Pikermi and those from Baltavar in Hungary which have been described by M. Suess. Besides these collections, I visited by the courtesy of M. Stur, the new director, the *Geologische Reichsanstalt*, which the fossils being arranged according to both the geographical and the geological order, is perhaps the finest collection of stratigraphic paleontology in Europe. Particularly to be admired are the ammonites from the trias of the Austrian Alps, respecting which M. de Mojsisovics has lately made some interesting publications.

I have not been in Pesth lately, but two learned Hungarian professors, MM. de Hautken and Szabo, have assured me that, since I last visited that city, its collections of geology and paleontology have become very important.

In Prague, Professor Fritsch conducted me to the place where the foundations of a grand Bohemian Museum of Natural Sciences have recently been laid. While awaiting the erection of this establishment, a special provisory hall of paleontology has been built near the old

Bohemian Museum, and here Professor Fritsch has collected and arranged in gradation numerous very remarkable fossils. The immense collection of the silurians, made by Barrande, and given by him to Bohemia, has been left in the apartments in the Chotek Gasse in which the eminent geologist resided. It is hardly possible to conceive of its richness in orthoceratites, cyrtoceratites, and trilobites. I saw an example here of the degree to which the love of paleontology may be developed, for in the more than humble rooms, where the eminent tutor of the Comte de Chambord passed most of his life, there are collections of primary fossils that cost enormous sums. Barrande was parsimonious toward himself, lavish to science. His collections are to be removed to the museum now in building. A young Czech professor, M. Novak, and a German geologist, Herr Waegen, distinguished for his works on the paleontology of India, are continuing Barrande's labors on the silurian formation of Bohemia.

Dresden, whose picture-galleries attract artists from all countries, has also greatly improved its galleries of geology and paleontology. Their director, Herr Geinitz, has arranged the fossils in geological order, so as readily to convey an idea of the history of past ages. The creatures of the Permian epoch are particularly well represented. No person has contributed so much as Professor Geinitz to the knowledge of that epoch, which was formerly believed to represent a moment of a slackening of the vital forces, but has furnished during several years past a multitude of fossil plants and animals.

Berlin has an entirely different character from Vienna. If we were living in pagan times, we might say that in Vienna they would raise statues in honor of Apollo, Minerva, and perhaps Venus, but in Berlin of Mars. Vienna is always panting for pleasures, especially the pleasures of the mind. Berlin, isolated in regions that the moraines of the glacial period left devastated, prefers the hard things of military life. But the government is interested in science as well as in military affairs, for it knows that intelligence makes strength. A large building has recently been erected in the Invaliden Street for the geological collections of which M. Hauchcome has charge, and another for the collections of agricultural arts in which M. Nehring has placed the curious quaternary fauna which he has described as the fauna of the steppes. Between these museums a grand Museum of Natural History is to be built. The university has excellent collections in geology in charge of Professor Beyrich, and in paleontology under the care of Professor Dames. Among them may be seen the second specimen of the archæopteryx, which cost three thousand dollars. It has the advantage over the specimen in the British Museum of possessing a head, and of showing its fore-limbs, the fingers of which are not united as in existing birds. Professor Dames has recently published an interesting memoir on this curious creature.

I might also speak of Russia, where I saw fine collections of fossils

at Dorpat, St. Petersburg, and Moscow; of Brussels, where the little Belgian state has made liberal expenditures for its iguanodons, mososauri, and hainosauri; and of Haarlem, in Holland, where the Jeyler Museum is being enriched every year with new paleontological curiosities; of Switzerland, which is not behind any country in the zeal with which it cultivates science; and of Italy, where science has its share in the revival which all departments of the intellectual life are enjoying. But I have said enough to show that paleontology is cultivated and held in high regard in Continental Europe, and that we Frenchmen also should not be indifferent to the questions of the origin and development of life.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

NITRIFICATION.

By Professor H. P. ARMSBY.

THE production of nitrates during the decay of nitrogenous organic matter under suitable conditions of moisture, aëration, and temperature, is a reaction of no little importance both technically and agriculturally: technically, as the sole natural source of saltpeter; agriculturally, on account of the fact that the nitrates formed in the soil constitute the chief if not the only supply of nitrogen to the plant. But, while the conditions of nitrification have long been well known, it is only within the past eight or nine years that its true cause has been recognized. Pasteur, in 1862, appears to have first pointed out the similarity of nitrification to the various oxidations of organic matter known to be effected by the agency of mycoderms, and of which the acetic fermentation is the typical example.

In 1873, A. Müller* advanced the opinion that nitrification was due to the action of a ferment. He based his opinion the fact upon that solutions of pure ammonium salts and of urea are very stable, while the same bodies in sewage are rapidly nitrified, holding that the difference was due to the presence of a ferment in the latter case. In 1877 Schloesing and Müntz † published the results of experiments which indicated that Pasteur's suggestion and Müller's opinion were correct, and that nitrification might really be classed as a fermentation. These experimenters were engaged in investigating the oxidizing effect of the soil upon sewage. They filled a glass tube one metre long with a mixture of quartz, sand, and a small quantity of powdered limestone, and caused sewage to filter slowly through this artificial soil, so that it occupied eight days in passing through the tube. For twenty days the sewage passed through unaltered. Then nitrates began to appear

* "Landw. Versuchs-Stationen," xvi, p. 273. † "Comptes Rendus," lxxxiv, p. 301.

in it, and rapidly increased in amount until all the nitrogen of the filtrate was in this combination. If nitrification is due to simple oxidation, it is difficult to see why it was so slow in commencing; but, if it is due to an organism which required time to develop in the artificial soil, the delay is at once explained.

Sewage was passed through the soil in this way for four months, with complete oxidation of its nitrogen. As soon, however, as vapor of chloroform, which is known to be inimical to the action of organized ferments, was caused to penetrate the soil, nitrification ceased, and did not recommence after the chloroform was withdrawn. After the sewage had passed unchanged for seven weeks, a small amount of turbid washings of a soil known to nitrify with ease was poured upon the top of the soil. After eight days (i. e., exactly the time required for the liquid to traverse the column of soil), nitrates reappeared in the strata, and continued to be formed as long as the experiment was continued. All these facts point plainly to an organism as the cause of nitrification. It developed in the soil during the first twenty days of the experiment from germs introduced by air or sewage; it was killed by the chloroform-vapor, and reintroduced in the soil-washing.

In 1878 appeared the results of experiments made by Warrington* in the Rothamsted Laboratory, which fully confirmed those of Schloesing and Müntz. He first showed that a very considerable nitrification took place in a good garden-soil when a current of air was aspirated through the moist soil, but that hardly any formation of nitrates took place when this air contained vapors of chloroform or carbon disulphide, while vapor of carbolic acid seemed to produce the same effect so far as it was brought in contact with the soil. Thus far the results were simply confirmatory of those of Schloesing and Müntz. Further experiments, however, developed the important fact that nitrification could be brought about in dilute solutions of ammonium salts, by seeding them with a small amount either of a nitrifying soil or of a similar solution which had undergone nitrification. The first experiments were made with the dilute solutions employed in the determination of ammonia by Messler's method, with the addition of small quantities of tartrate and phosphate of potassium, and precipitated carbonate of calcium. The solutions used in later experiments had the following composition per litre:

Ammonium chloride	80	milligrammes.
Sodium potassium tartrate	80	"
Potassium phosphate	40	"
Magnesium sulphate	20	"

Precipitated calcium carbonate was added to supply the necessary base. By this discovery the way was opened for the easy and fruitful study of the process and of the conditions affecting it.

Since the publication of Warrington's paper, a large amount of

* "Transactions of the Chemical Society," 1878, p. 44.

work has been done in this direction both by this investigator and by others. As a result, the ferment theory of nitrification has been very thoroughly established, the organism producing it has been isolated, and considerable progress made in the study of the conditions affecting nitrification, particularly in fluid media.*

That nitrification is due to the action of a living organism is shown in various ways. Sterilized solutions, otherwise suitable for nitrification, have been preserved for as long as three years unchanged. But, if to such a solution a small amount of a solution or a soil in which nitrification has recently taken place be added, the solution nitrifies within a short time.

Nitrification is strictly confined to the range of temperature within which the action of low organisms is possible. It does not take place unless all the nutritive materials necessary for such organisms are present, absence of phosphoric acid, for example, completely preventing it. Antiseptics, as already illustrated, inhibit nitrification. The action of heat likewise confirms the ferment theory. The temperature of boiling water at once stops nitrification, and it is not resumed until the medium is seeded again from some external source.

Some of the more important conditions affecting nitrification in liquids (and presumably also in porous solids, such as soil) are: 1. Alkalinity of the solution; 2. Concentration of the solution; 3. Character and amount of the ferment; 4. Temperature.

1. While nitrification does not take place in the absence of a salifiable base, any considerable degree of alkalinity greatly retards it, and, if it exceeds the equivalent of about three hundred and fifty parts of nitrogen per million, stops it.

2. Under like circumstances, nitrification begins more promptly the more dilute the solution. No definite limit of concentration can be stated, beyond which nitrification can not take place on account of the great differences caused by differences in the—

3. Character and amount of the ferment. The character of the ferment is determined by its previous history. A strong ferment, producing prompt and rapid nitrification, is obtained by repeated cultivations in moderately strong solutions well supplied with nutritive matter, while the opposite course produces a weak ferment. The stronger the ferment, and the greater the amount of it used for seeding, the sooner the nitrification begins, and the greater is the admissible concentration of the solution.

4. Nitrification has been observed to take place at a mean temperature of 3·2° C. The superior limit seems to be 40° to 50° C., the optimum 35° to 37° C.

A variety of nitrogenous substances have proved susceptible to nitrification in solution. The weight of evidence, however, appears to

* Compare especially Warrington, "Transactions of the Chemical Society," 1884, p. 637.

show that in all cases the nitrogen first assumes the form of ammonia, and that the latter is, strictly speaking, the only substance capable of being nitrified. In the case of urea this has been observed to lead to some interesting results. Thus, if nitrification is induced in a solution of urea containing no salifiable base, the process stops when one half the nitrogen has been oxidized, ammonium nitrate being produced. If the concentration exceeds a certain limit no nitrification occurs, the alkalinity produced when the urea is converted into ammonium carbonate being sufficient to prevent the action of the ferment. If, however, gypsum be present, the well-known double decomposition into calcium carbonate and ammonium sulphate takes place, and, the latter having a neutral reaction, nitrification proceeds unhindered.

An interesting and hitherto unexplained fact which was noticed in Warrington's experiments is, that sometimes nitrous and sometimes nitric acid was produced, and at times both in the same solution. The experiments thus far published suggest the possibility of the existence of two ferments, a nitric and a nitrous, but on this branch of the subject we may expect more light when investigations now in progress at Rothamsted are made public.

Some investigations into the distribution of the nitric ferment in natural soil are summarized by Warrington as follows: "I am disposed to conclude that in our clay soils the nitrifying organism is not uniformly distributed much below nine inches from the surface. On much slighter grounds it may perhaps be assumed that the organism is sparsely distributed down to eighteen inches, or, possibly, somewhat farther. At depths of from two feet to eight feet there is no trustworthy evidence to show that the clay contains the nitrifying organism. It is, however, probable that the organism may occur in the natural channels which penetrate the subsoil at a greater depth than in the solid clay. In the case of sandy soils we may probably assume that the organism will be found at a lower depth than in clays."

SKETCH OF GENERAL JOHN NEWTON.

GENERAL NEWTON has commended himself as one who is entitled to acknowledgment for useful and distinguished service in two fields. As a member of one of the branches of the military establishment he did active duty as an army engineer and a commander of men, acquitting himself with honor on every occasion, during the whole period of the war of the rebellion. In peaceful times, his career has been within his own preferred field of work, where theoretical knowledge and practical skill in application and execution were equally in demand, and were united in carrying out the important enterprises that were intrusted to him. In his works as an engi-

neer, which may be found all along our Atlantic sea-coast, and particularly in the clearing of the channel of Hell-Gate, he has shown himself a man who held the resources of science in his hand, and knew exactly what to do with them; and in the use he made of them, to promote the greatest public benefit, the originality of the devices which he contrived, and the certainty with which he accomplished his designs, he has shown himself to possess the highest title to scientific recognition.

John Newton was born in Norfolk, Virginia, August 24, 1823. His father, Thomas Newton, represented the Norfolk district in Congress for thirty years, and was, when he retired, the oldest member in service in the United States House of Representatives. After having been given such instruction as the schools of Norfolk could confer, young Newton, when about twelve years old, was placed under private tuition, especially in mathematics, for which he showed a marked taste, with the purpose, already formed, apparently, of making a civil engineer of him. He entered the Military Academy at West Point in July, 1838, where, we are informed, his worth as a careful and comprehensive student was known and recognized by his superiors, and his natural bent and acquirements were at once given opportunity for play. Upon his graduation from the Academy in 1842, he was appointed a second-lieutenant in the Corps of Engineers. He served as assistant to the Board of Engineers in 1842 and 1843; and in the Academy, first as assistant professor and afterward as principal assistant Professor of Engineering, from 1843 to 1846. In the latter year he was designated as assistant engineer in the construction of Fort Warren, Boston Harbor, and Fort Trumbull, New London, Connecticut. From this work he was transferred to be superintending engineer of construction of Forts Wayne, Michigan, and Porter, Niagara, and Ontario, New York. In 1852 and 1853 he was engaged in superintending the surveys of Cobscook Bay, Kennebec River, and Matinicus Islands; and for the breakwater at Owl's Head, in Maine. Next we find him in Florida on similar work, looking to the improvement of St. John's River, the Haul-over Canal, and the repair of the sea-wall at St. Augustine; in Georgia, looking after Forts Pulaski and Jackson, and the improvement of lighthouses on Savannah River; at Sullivan's Island, attending to the trial and inspection of the dredge-boat for the bar; and again in Florida, supervising the fortifications and lighthouses of Pensacola Harbor, from 1855 to 1858.

He was appointed in 1853 a member of the commission for devising a project for the improvement of St. John's River; in 1856, of the board to examine Pensacola dock; and of the special board of engineers to select sites and prepare projects for the coast-defenses of Alabama, Mississippi, and Texas. There also appears, under the date of July 1, 1856, a record of Lieutenant Newton's appointment as captain of engineers, for fourteen years' continuous service. He was

made chief engineer of the Utah Expedition in 1858, and afterward superintending engineer of the construction of Fort Delaware, and of repairs of Fort Mifflin, Delaware Bay; and of the special board of engineers for modifying the plans of the fort at Sandy Hook, and for selecting sites for additional batteries at Fort Hamilton.

These occupations engaged his attention down to the time of the outbreak of the rebellion in 1861, when he entered the active service as chief engineer of the Department of Pennsylvania, in which capacity he accompanied General Paterson's column in the Valley of Virginia, and was engaged in the action of Falling Waters. He was also, in this year, chief engineer of the Department of the Shenandoah, assistant engineer in the construction of the defenses of Washington, and commander of a brigade in the defense of the capital, till March 10, 1862; and was appointed major of the Corps of Engineers and brigadier-general in the volunteer service. In 1862 General Newton served in the Army of the Potomac in the Peninsular and Maryland campaigns, and was engaged in the actions at West Point, Gaines Mill, and Glendale; in the retreat from the second battle of Bull Run; and in the battles of South Mountain and Antietam. At West Point, when it was found that the Union army was threatened by the interposition of the forces of Gustavus W. Smith, at Barhamsville, with their retreat cut off by the river in their rear, Newton went out at dawn to reconnoitre. He found that marshes covered all their position except a space sufficient for the movements of one brigade. He planted his own brigade there, and with it held the post against attack. At South Mountain General Newton's brigade, attached to General Franklin's corps, was one of the three brigades composing the division of General Slocum, which advanced up the side of the mountain, and repulsed the enemy's force. The same brigade won formal commendation for its behavior at Gaines Mill and at Glendale; and its commander was brevetted lieutenant-colonel (regular army) September 17, 1862, for gallant and meritorious services at the battle of Antietam.

General Newton was given the command of a division in the Rappahannock campaign, in which he was engaged in the battle of Fredericksburg. In the Chancellorsville campaign, having been in the mean time made a major-general of volunteers, he was attached to General Sedgwick's corps, counseled and participated in the storming of Marye Heights, and took part in the battle of Salem. In the Pennsylvania campaign he participated in the eventful battle of Gettysburg, and took the temporary command of the First Corps after the death of General Reynolds, and in that capacity followed in pursuit of the enemy to Warrenton, Virginia. For his gallant and meritorious services at Gettysburg he was, July 3, 1863, brevetted colonel. He still commanded the First Corps in the Rapidan campaign; but, when the "march through Georgia" was about to be entered upon, he was transferred to the Army of the Cumberland, and put in command of

the second division of the Fourth Corps (General Howard's). In this campaign he was engaged in the storming of Rocky-faced Ridge, where the corps succeeded in carrying the ridge; in the operations around Dalton, the turning of which was regarded as a great step gained in the movement upon Atlanta; in the battle of Resaca; in the action of Adairsville, where his division had a smart skirmish with the enemy's rear-guard; in the pursuit of the enemy to the Etowah River, with constant skirmishing; in the battle of Dallas; in the movement on Pine Mountain, with almost daily heavy engagements; in the battles of Kenesaw, where, in McPherson's attack on Little Kenesaw, parts of his division were engaged in the assault by which the enemy's works were reached after a charge up the face of the mountain against a heavy fire. After the crossing of the Chattahoochee River, in closing up the Federal lines around the northern and eastern sides of Atlanta, General Newton's division was left to hold an important position on Peach-Tree Creek with an inadequate force, which offered itself as a temptation to the newly appointed Confederate commander, General Hood, to attack it. The readiness with which his command met Hood's sudden assault, and the efficiency of their fire, assisted by the batteries which General Newton had posted on each of his flanks, were material in deciding the failure of that attack. For this and for other gallant and meritorious services in the campaign he was, in March, 1865, brevetted brigadier-general in the regular army.

During the siege of Atlanta, General Newton participated in the attack on the enemy's intrenchments at Jonesboro, September 18th; in the battle of Lovejoy's Station on the next day; and in the events more immediately relating to the occupation of the famous stronghold. He was afterward assigned the command of the district of Key West and Tortugas, Florida, in which capacity he was engaged in the action of the Natural Bridge, near St. Mark's. On the 13th of March, 1865 —the same day on which he was brevetted brigadier-general for his services in the Atlanta campaign—he was also brevetted a major-general in the United States Army for meritorious services in the field during the rebellion. On the 28th of December, 1865, he was made a lieutenant-colonel in the Corps of Engineers. On the 15th of January, 1866, he was mustered out of the volunteer service.

He was transferred at once to engineering service, to have charge of the construction of the new battery near Fort Hamilton, in New York Harbor, and of the construction of the fort at Sandy Hook. In 1866 he made an examination for the improvement of the navigation of Hudson River, the appropriation then being sufficient only for the repair of the dikes already constructed; but his report covers the whole ground, and the scheme then proposed is that which has been carried on latterly entirely under his charge. The character of the improvements then indicated was—1. A system of longitudinal

dikes of a height not to exceed that of high water. 2. The dredging of the loose and movable material from the bottom. 3. The direction of the channel as defined by the dikes to be as straight as possible, and the changes of direction to be made by easy curves. 4. A gradual increase in width of the channel from Troy to New Baltimore as being more favorable for a higher rise of tides. 5. The closing of the side-passes generally, but leaving an opening for the influx of the flood. 6. Revetting of island-shores and river-banks where exposed to abrasion. 7. The limits of the encroachment on the river-bed to be defined and enforced by proper authority. 8. Deposition of dredged material beyond the action of currents. 9. The abandonment of the idea of obtaining a scouring effect by the height of the dikes. In fine, dikes are advocated with the view to give direction to the freshet, flood, and ebb currents; to prevent cross-currents, and consequent filling up of the channel; to lead and bring up a greater volume of tidal waters; and, consistently with these objects, the dikes should be constructed as low as possible, in order to allow the freshet-water to spread. Estimates were made for the work, to be completed in five years; it is still not complete, nor has the work been carried on without opposition from steamboat-men and parties judging that they were to be pecuniarily injured. Near Coeyman's this opposition was very strong, but, since construction, the opponents have acknowledged that their apprehensions of inconvenient results were erroneous, and have been satisfied with General Newton's engineering.

Gradually with the extension of navigation improvements General Newton reported on all the channels and harbors in the vicinity of New York, from Lake Champlain on the north to the Raritan and Arthur's Kill on the south, superintending constructions where appropriations had been granted. He was also one of the commissioners for the improvement of the harbor of Montreal.

But the great construction with which General Newton's name is identified is the improvement of the Hell-Gate Channel, the important water-way between Long Island Sound and East River, of New York city. His first examinations for the improvement of Hell-Gate, and the report, with cost of constructions, were made to Congress February 12, 1867. The first propositions were merely tentative. The plan recommended for the removal of reefs was by holes drilled from a platform above water. A contract was given to Maillefert & Co. to remove Pot Rock and some other like obstructions by depositing explosives on the surface of the rock and firing them. This was found to be very expensive and tedious, and the contractor who undertook to drill from above the water was not successful.

In June, 1869, General Newton submitted a report for the removal of Hallet's Point by sinking shafts on the shore-side to a sufficient depth, and from the bottom of these shafts running galleries under the rock to be removed, the opening below being calculated to be

sufficient to remove all the rock from above. The same project was to be applied also to the Gridiron Reef. This method of excavation was not new, as it had been proposed by General Alexander, of the United States Engineers, for the removal of Blossom Rock, San Francisco Harbor, and afterward carried out by Van Schmidt, a civil engineer; but that reef was a very small one in comparison with those to be removed at Hell-Gate. The general also, in the same report, proposed a plan for a scow to remove the isolated reefs. This scow was constructed in 1870. It consisted of an iron dome thirty feet in diameter, supported centrally in a well, in a scow one hundred and twenty feet long by forty-eight feet beam; this dome could be raised or lowered by derricks on the scow. When resting on the rock, the space inclosed was virtually cut off from all currents, the drills could be worked steadily, and the space was accessible to divers. Above the dome were steam-drills, the drills passing through tubes in the dome. This dome-scow proved a practical success, and was not only used at Hell-Gate but also on other reefs, as at Coenties and Diamond Reefs.

The progress was so satisfactory at Hallet's Point that shafts were sunk at Flood Rock in 1876. General Newton had been at the same time making extensive experiments on all the known explosives, to test their applicability to the breaking up masses of stone, while extensive experiments were also made with batteries, wires, and fuses, with a view to their use in the final blast. The excavation being completed, and the mines charged and wired, the explosion at Hallet's Point took place September 24, 1876.

It was a success. The work at Flood Rock was prosecuted more energetically, but with varying appropriations; essentially in its general features it was like the work at Hallet's Point, but with such modifications as had been developed by experience. In one essential feature both differed from what had been originally designed by General Newton. In his first report he had proposed to make the cavities of the galleries sufficient to receive the superincumbent stone. As he proceeded, he did not consider this necessary; a great deal of stone since the blast at Hallet's Point had been removed by grapples, which was practically found to be cheaper than by mining. In its application to the work at Flood Rock, the spaces were smaller compared with the solid rock than at Hallet's Point; galleries were considered only necessary to give access, so as thoroughly to shatter the rock. Flood Rock was fired on the 10th of October, 1885, and a full description of the work was furnished by General Newton for the February number of this journal.

All the problems which were involved in the several steps leading up to the consummation of that stupendous work were completely and conscientiously studied out; and the accuracy of the studies was fully exemplified in the exact correspondence of results with what was aimed

at that was realized in every part of the labors. The resources of science were drawn upon with an unerring vision of their scope; the appliances of engineering art were employed with precise adaptation to their purpose, and an exact measurement of the effect they were intended to produce; so that in all that has been achieved there has been no failure and no waste. The demonstration which General Newton has made in this work of the power of science, whose least effort can be made useful to such immense results, commands its recognition of him as its vigorous man of action. The knowledge and skill which he has thus been able to apply to such exact measurement and direction are the outcome of a life of special training and exercise; and it would be hard to produce a higher testimonial to the value of the faithful pursuit of the studies that relate to the work one is destined to do in the world than these achievements at Hell-Gate.

There is yet one enterprise connected with the improvement of the harbor of New York—the opening of the Harlem River to Spuyten Duyvel, on which General Newton reported in 1875 and 1876—which has been postponed by conflicting interests of property-owners and the difficulty of securing rights.

Since his station at New York, General Newton has often been called into consultation on many civil-engineering works. In connection with the various duties of his office his experience has been large and varied, and it would be impossible to name an engineer who has been so uniformly successful.

Recently, when the city of New York—having a more important work in view than it had yet undertaken in a municipal capacity—found it necessary to secure a man of superior skill and scientific training to superintend its Department of Public Works, General Newton's name was the first, and, we might well say, the only one that suggested itself. The only doubt expressed on the subject was whether he would be willing to leave the body with which he had been connected all his life, with such distinguished honor, for one the record of which has not always been free from the taint of political manipulations. This question was happily solved by General Newton's declaration of his willingness to accept the position on the retired list of the army, to which he was entitled, in order to go to the place where he was more needed. The fitness of his appointment has been universally recognized, and is most felicitously expressed in the words of one of the newspapers, that he is the "ideal man" for the position.

CORRESPONDENCE.

THE PHYSIOLOGY OF EXERCISE.

Messrs. Editors:

WHILE all must agree with Professor Richards as to the importance of physical exercise to the brain-worker, there are some points in his article on "The Influence of Exercise upon Health," in the "Monthly" for July, 1886, requiring comment.

On page 328 he says: "When we use our muscles, their contractile force upon the blood-vessels helps the blood along its channels, and thus takes a little labor from the propelling heart. It beats faster, but with less effort."

It is admitted that contracting muscles by their lateral pressure promote the flow of blood through the veins; but the work of the heart is not lessened thereby, because the force of the heart-beat is not expended in propelling the blood through the veins, but (according to Foster) in expanding the elastic arteries and overcoming the friction between the blood and the walls of the arteries and capillaries. This friction is called the peripheral resistance. Now, whatever diminishes the caliber of the terminal arteries and capillaries increases the peripheral resistance; and, if the contracting muscles have any effect upon these vessels, it is to lessen their caliber and so increase the peripheral resistance, thus throwing more work upon the heart.

The heart beats faster, but does it beat with *less effort?* Du Bois-Reymond ("The Physiology of Exercise," "Popular Science Monthly," July, 1882) says: "Under continuous severe exertions, as in mountain-climbing and long walks, the heart begins to beat faster and *more strongly;* because, according to Traube, it is stimulated by excess of carbonic acid formed in the laboring muscles; according to Johann Müller, because it participates in a by-motion."

How is it, if muscular exercise lessens the work of the heart, that excessive and long-continued muscular exertion causes hypertrophy and even valvular disease of that organ? Yet such is the case, according to such eminent authorities on medical matters as Drs. Da Costa, A. L. Loomis, the late Austin Flint, and others. This is a matter of great importance from a medical standpoint, for, if muscular exercise lessens the work of the heart, our medical writers have all gone wrong in saying that the most essential item in the treatment of a diseased and overtaxed heart is rest.

Again, the professor quotes Maudsley as follows: "By one organic element of the body the blood is purified from the waste matter of a higher element, which would be poisonous to it." This is undoubtedly true. The lungs, kidneys, and other excreting organs certainly do eliminate materials which would be poisonous to other organs. But Professor Richards applies this remark to the muscular and nervous systems, which, I think, he is not warranted in doing, as I shall endeavor to show.

He says (page 332, July "Monthly"): "A tired brain and quivering nerves may not be more wearied by physical exercise, but may be refreshed by it. This refreshment may result from two processes: First, by drawing the excessive blood-supply from the before active organs; and, secondly, by purifying the blood so that it may be ready to properly nourish the brain."

In the first place, it is not the excessive blood-supply that makes the brain tired, the increase of blood being caused by the increased demand of the functionally active organs. In the second place, contracting muscles, as the result of the chemical changes that take place in their substance, form lactic acid, keratin, and carbonic acid. The last, according to M. Foster ("Text-Book of Physiology"), acts upon the central nervous system as a narcotic poison. The brain forms keratin during functional activity. Now, since one product of muscular action is a narcotic poison, and another is a waste product of the brain, it is inconceivable how the blood is purified and better fitted to nourish the brain.

If, as Professor Foster says, "the fatigue of which, after prolonged and unusual exertion, we are conscious in our own bodies arises chiefly from an exhaustion of the central nervous system concerned in the production of voluntary impulses," then Professor Richards's statement, that the time for exercise is when the brain is tired and one feels inclined to rest and to forego exercise, is open to question. May it not be that the indisposition to take active exercise when fatigued by brain-work is rather conservative, just as is the natural tendency to rest after a full meal during the process of digestion? Respectfully,

A. B. Rosenberry, M. D.

Sheboygan Falls, Wisconsin, *July* 8, 1886.

A CURIOUS OPTICAL PHENOMENON.

Messrs. Editors:

A strange phenomenon was observed here at a few minutes before sunset yesterday evening. A heavy storm had come up

in the afternoon, and during a cessation, shortly before sunset, the light burst through the clouds in the western sky and a most magnificent rainbow appeared in the east, with the top of the circle about fifty-five degrees from the horizon. All that portion of the clouded sky within the circle changed to a brilliant red color, while all without the circle was of a dull bluish-gray shade. The rainbow thus formed a sharp division between the two portions of the sky which were in such striking contrast to each other. For a time the red sky inclosed by the rainbow was so deeply colored that the red portion of the rainbow, which was in itself remarkably brilliant, could not be distinguished from it, but it appeared as though the red part of the rainbow had spread out, covering the entire plane inclosed within the circle. A similar phenomenon never having come before my notice, and having never read an account of one, I would respectfully ask the editors of "The Popular Science Monthly," or the intelligent readers thereof, to furnish me with an explanation. Why should the red portion of the clouded sky within the circle and the bluish-gray portion without be so sharply defined and divided by the rainbow?

Very respectfully, B. F. Thomas.

Morning Sun, Iowa, *August* 14, 1886.

"ANIMAL AND PLANT LORE OF CHILDREN."

Messrs. Editors:

Reading "Animal and Plant Lore of Children," in your publication for July, called to mind a few beliefs that children had in Southern Illinois twenty years ago, and which were not enumerated in the article referred to. Snakes were numerous, and the subject of many superstitions. To kill a snake and hang its body on a living bush would produce rain within twenty-four hours. Snakes delight in the hot sun-rays which precede a thunder-shower, and are often killed at such times. It was a general belief that live coals placed on a snake would cause four legs to grow from its body. To inhale the breath of a snake was sure death to the child who met with such an accident. Children were firm in the belief that snakes could charm them if they gazed steadily at the reptiles' eyes. It was bad luck not to kill the first snake seen in the spring. The negro children believed that the lives of snakes were guarded by the devil.

The "tobacco-juice" expectorated by grasshoppers was a sure cure for warts. Bean-leaves not only cured warts, but killed cancers.

Bad luck befell the person who saw a rabbit cross his path, unless out on a hunting expedition. If a child killed a cricket, his clothes would be ruined by other crickets.

Toads or humble-bees entering the house were as sure signs of company as the crowing of a rooster at the front door.

Frost always made its appearance just six weeks from the time the first katydid was heard.

Cats were credited with nine lives, and turkey-buzzards with the power to vomit on naughty children.

In fishing, a few drops of blood on the bait were more valuable than spit or hare callosity. The latter was also a cure for toothache.

The ant-lion was enticed from his den by repeating, "Noodle! noodle! come out of your hole!" He was then punished by death for being so easily fooled.

Purposely to kill a lady-bug would cause sickness, and accidentally to do so, some kind of bad luck.

Many of these beliefs were held by grown persons as well as children, while adults had many superstitions which children could not understand.

H. M. Whelpley.

St. Louis, Missouri, *July* 10, 1886.

EDITOR'S TABLE.

FRAUD AND ITS VICTIMS.

Nothing could better illustrate the great need that exists, even in this highly favored country, for a more general diffusion of intelligence, than the extent to which people, who can at least read and write, allow themselves to become the dupes of the most transparent impostures. The post-office authorities are engaged in a perpetual struggle to prevent people, who would be deeply offended if they were spoken of as deficient in intelligence, or if any one hinted that they were not fully, if not superabundantly, qualified for the highest duties of citizenship, from parting with their money to impudent adventurers who advertise their ridiculous and utterly fraudulent schemes in the newspapers. At one end of the coun-

try is a lottery, at another a mining speculation; here a gift concert, there a family newspaper sent free for six months with valuable premiums into the bargain; one man has a remedy for every form of disease, another is prepared to reveal an easy and delightful way of making a fortune in a few weeks: it matters little what the pretense is, the fly is no sooner cast than some silly fish begin to rise. Those who pride themselves on being more knowing than their neighbors nibble a little at the bait at first, and enter into correspondence with the advertiser. The latter knows just what to do with such customers. He sends them the most solemn protestations that his business is *bona fide*, and his personal reputation beyond all possibility of attack. He is prepared to show testimonials by the thousand as to the thorough uprightness and eminently satisfactory character of his dealings. That is enough: the money comes forward by the next mail, and one more gudgeon is hooked.

It may be asked what all this has to do with science. Well, a good deal; or, if not with science, at least with the want of it. What are the schools of the country doing, let us ask, that the Post-Office should have to step in to save the free and enlightened citizens of this republic from the consequences of their own ignorance and folly? The object of popular education, we make bold to say, ought to be to give the people sense; yet here we have indisputable evidence that large masses of our population don't know enough to protect themselves against the most barefaced forms of imposture. The intellectual quality most largely developed in certain extensive regions of society would seem to be credulity. How does this fact tally with our supposed educational progress? Evidently we are here face to face with a question which should come home very directly to all who are interested in public education; and we would respectfully ask teachers and trustees to consider whether, through the schools, something might not be done to diminish an evil which really has assumed very large proportions. Let *private* education pursue what ends it will; but public or state education, we hold, should aim, above all, at the production of good and efficient citizens. But a man is not an efficient citizen who is so grossly credulous as the majority of those who fall a prey to the advertising quack or confidence-man. A part, and no mean part, of the exercises of every school should consist of the imparting to the pupils of sound practical precepts bearing on civil and social life. We want to develop common sense in the young; we want to give the boys a manly bearing and manly ideas; we want to qualify the girls to act with sound judgment and right womanly feeling in the several positions in life they may be called upon to fill. We want to show that the lust of wealth is a poor motive for any man's or woman's chief activity. But how is all this to be done? The mere teaching of arithmetic, geography, and grammar will not do it. It can best be done, as it seems to us, by a scientific, that is to say, a rational exposition, on the one hand, of the principles which go to produce the dignity, security, and happiness both of nations and of individuals; and, on the other, of the causes which lead to national decay and individual misery. In connection with such a course of lessons as we have now in view, it would be well to glance at some of the methods by which dishonest men prey upon society, and, by way of illustration, we can hardly imagine anything more serviceable than an analysis of the advertisements and circulars of some of the "frauds" operated through the post-office. The children who heard these things exposed would carry home the information to their parents; and the net result in many cases would be an en-

largement of the common sense of the household, and the saving of a good many dollars of hard-earned money. It may perhaps be objected that ill-disposed boys would thus learn tricks that they might afterward attempt to practice. The same risk, however, attends every exposure, in the press or elsewhere, of vice or crime; and we think that an honest teacher could hardly fail to present the subject in a manner that would leave a large balance of good effect.

If there is anything that schools maintained by the State might be expected to do, it is to inculcate respect for the State, and in general to develop a sense of the debt which each individual owes to the society of which he forms a part. Nothing is easier to show than the entire dependence of the individual upon society for all that makes life worth living; and it ought not to be impossible to draw out certain feelings of regard and devotion toward the organism in which and through which alone individual life rises to any true worth or dignity. It can be shown that, just as the family, in the first place, educates the individual by taming his selfishness and developing his sympathies, so the State or community educates the family by widening its interests, multiplying its activities, and calling into existence those thousand differentiations, complications, and refinements of thought and feeling which distinguish civilized man from the savage. Were these lines of thought properly worked out, we believe they would be found to furnish the basis for an almost religious sense of duty to the State; and would certainly set in a strong light the odiousness of such treason to it as is involved in private fraud and in public corruption.

We shall only say in conclusion that it would, in our opinion, be well if the public would get more and more into the way of testing our school systems by their apparent practical results as regards the moral and intellectual life of the community. We ought to be able to form some idea as to whether the rising generation are growing up wiser and better than ourselves, or just about the same, or worse. We should postulate distinct improvement; and, if such improvement is not apparent, we should try to find out the reason why.

THE BUFFALO MEETING OF THE AMERICAN ASSOCIATION.

The American Association met this year in its thirty-fifth meeting at Buffalo. It is the third time it has assembled in that city, its fifteenth and twenty-fifth meetings having also been held there. It is also a fact, of which the people of Buffalo took notice with a gratification they had a right to feel, that their city is the first place which has as yet enjoyed the privilege of entertaining the Association for the third time. The Hon. Sherman S. Rogers, who delivered one of the addresses of welcome, referred to the fact as significant of a growing regard among the people for those pursuits which contribute to the advancement of knowledge, irrespective of their bearing upon business, and as evidence that, eager as that active and enterprising city is in the material pursuits of life, "it is waking up to the conviction that man does not and can not live by bread alone." The same thing is going on in the other cities of the country, large and small, where increased appreciation is shown every year of those things which pertain to learning for its own sake, and where even the most active centers of commercial speculation have their academies working industriously in pure science.

The attendance was good, and the list of members is marked by the presence of a large proportion of those who have attained a solid reputation in their respective branches of science. The programme of the papers also exhibits

a greater predominance than has usually obtained of late years of those that are of real scientific or practical value, with a corresponding absence of the vagaries of such persons as President Morse described as "cranks." Retiring President Newton selected meteorites as the topic of his official address, which we publish entire in this number of the "Monthly," the subject with the investigation of which his fame is most closely associated. With a few plain, common-sense considerations which everybody could comprehend, expressed in language intelligible to the most unlearned of his possible hearers, he disposed of most of the theories which have been devised to account for these phenomena, showing how inadequate they are, and then considered, without committing himself definitely to what no one knows, the only one yet advanced which is plausible in the present condition of science. Of the vice-presidential sectional addresses, that of the Hon. Horatio Hale, in the Anthropological Section, presented the subject of "The Origin of Languages and the Antiquity of Speaking Man," in a somewhat different light from that in which it has been regarded by the majority of anthropologists of the present generation. Professor Wiley's address on the "Economical Aspects of Agricultural Chemistry" is of practical interest, and will probably attract more general attention. Professor Brackett's address in physics, and Professor Bowditch's in biology, are of technical interest. In geology, Vice-President Chamberlain presented "An Inventory of our Glacial Drift." Vice-President Chanute, in the Mechanical Section, showed how inventors are indebted to science; and in the Economical Section Vice-President Cummings considered the well-worn questions of the improvement of the condition of laborers, the causes of discontent among them, and their errors. The Association meeting so near to Niagara, the geological origin and character of the Niagara River and Falls naturally claimed a large share of attention. A graceful recognition was made of the approaching completion of the hundredth year of the veteran chemist, Chevreul. In commenting upon the meeting of the Association in Buffalo ten years ago, we spoke of a seeming lack of papers and discussions suited to the wants of the citizens at large who attended the sessions in expectant interest. We observe in the proceedings of the present meeting an improvement in this respect. While the technical side was not overlooked, and little that was unscientific was presented, the addresses of President Newton and Vice-President Wiley, the Niagara discussion, and other papers to which we have referred, were, both in matter and manner of presentation, well adapted to a popular audience.

LITERARY NOTICES.

Outlines of the History of Ethics for English Readers. By Henry Sidgwick. London: Macmillan & Co. 1886. Pp. 271. Price, $1.50.

Leaving Herbert Spencer out of consideration, no living or recent writer has made an impression on ethical thought equal to that of Professor Sidgwick. Whatever he produces, then, might naturally be expected to be of value. Our anticipations are not disappointed in this little volume. As far as it goes, it is, without doubt, the most thoroughly admirable treatise upon the history of ethics extant. This praise is due for its conciseness, for its impartiality, and for its accuracy. It is an excellent college text-book, and also full enough to give the general student a better idea than he can elsewhere obtain of that portion of ethical history which it covers.

This book is by no means a mere chronology. It is full of the evidences of careful critical study. The essential features of the different ethical systems are grasped with certainty and presented with remarkable clearness. We get from this presentation many new ideas, both of the tenets

of philosophers and their true relationship to each other. The points of agreement, for example, between Plato and Aristotle, as indicated by the author, are very impressive. The relations of pre-Socratic ethics to these latter are well shown. The translation of εὐδαιμονία by "well-being," instead of the usual "happiness," gives us quite a different conception of much of the Greek ethical philosophy. The contrasts between Stoicism and Epicureanism are sharply and truthfully drawn. The influence of the Roman jurisprudence upon ethical development is exhibited in a manner indicating the author's knowledge and appreciation of the work of scholars like Sir Henry Sumner Maine. Mediæval ethics and Christianity are treated without leaving the reader's mind in a state of hopeless confusion respecting the landmarks of progress and the work of individuals with whose names we are familiar, but of whose special value we can ordinarily learn but little from philosophical and religious histories. The chapter on modern English ethics is conspicuously free from controversial matter and from the *animus* of the partisan. All through, we find new ideas which reveal critical acumen, and compel us, if not to change, at least to reconsider our conclusions on many special points of historical fact. For instance, we are somewhat startled by the opinion that in the latter part of Plato's life, when he wrote the "Timæus," he did not believe in the immortality of the individual soul. Again, the average reader will probably be somewhat surprised to learn that Bishop Butler held self-love and conscience to be independent principles, and so far coordinate in authority that neither should be overruled by the other; if either were to give way, it must be conscience. Also, the importance of such works as Price's "Review of the Chief Questions and Difficulties of Morals" (1757), and Gay's "Essay," prefixed to Law's translation of King's "Origin of Evil" (1731), in the history of English ethics, is seldom considered and nowhere else saliently brought out.

All these considerations awaken regrets that the work before us is avowedly incomplete. The author says, by way of explanation, that, since the foundation of this book was an article written for the "Encyclopædia Britannica," after some hesitation he concluded to retain his original plan, and deal only with modern ethical systems as they relate to English moralists. We think this was decidedly a mistake. It detracts very considerably from the usefulness of the treatise. There is no utility, even for English readers, in presenting the ethical movements of Continental thought as an appendage to English ethics. The French and German systems have contributed powerfully to form the principles of morals, and very extensively to determine character and conduct. The French Revolution was primarily a political convulsion, but the ethical influences contributing to bring it about, and which it in turn generated, were very noticeable and important. They ought to be fully traced out in a history of ethics. So, too, the Kantian philosophy is surely worthy of a more thorough exposition and criticism than that of a half-dozen pages at the end of the volume. Again, the leading phases of Oriental ethical development are of the highest consequence in such a history. These defects could have been supplied, not, indeed, without enlarging the book; but we think the resultant advantage would have been ample justification for the addition.

Numbers Illustrated and Applied in Language, Drawing, and Reading-Lessons. By Andrew J. Rickoff and E. C. Davis. New York: D. Appleton & Co. Pp. 160. Price, 42 cents.

This is an arithmetic for primary schools, and is the first in the series of "Appletons' Standard Arithmetics." It is the fruit of many years of careful preparation, combined with extended research as to the best methods now in use, and much experience in class-room work and school supervision. Its design is to familiarize the child with numbers and their combinations by some better and more lively method than the mechanical and rote repetition of the formulæ of the addition and subtraction and other tables. Instead of this, it attempts to provoke observation of the things the numbers represent, and to lead the pupil to the utterance of the formula as a statement of his own experience. In the earlier lessons, in the first part of the book, the properties of numbers are illustrated by the aid of three series of pictures

for each of the digital numbers. The pictures of the first series are designed for language-lessons, in which the particular number is brought in and visibly represented, and the immediate design of which is to excite thought and cultivate expression. The second series consists of slate exercises involving the numbers to be copied with changes; and these are afterward changed into diagrams, combining exercises in elementary drawing, into which the several numbers also enter. The third series of pictures, entitled "What can you tell?" presents combinations, with the numbers still the most prominent objects to be considered, which the child is invited to describe, or concerning which he may compose a story—exercises which call the imagination into play, and encourage independent and original expression. These lessons are followed by a series of reading-lessons in number and dictation exercises, in combinations of from one to ten, with the pictorial element still employed. In the third part are given combinations in numbers from ten to twenty.

Geological Studies. By Alexander Winchell. Chicago: S. C. Griggs & Co. Pp. 513. Price, $3.

This book, representing a more advanced stage of the study of geology than is furnished in the author's "Geological Excursions," is intended to introduce the reader to the science by some natural and pleasant method; to help him to see things for himself, and draw his own conclusions from them. It is, therefore, designed to be a guide to the observation of Nature, and a synoptical record of the more important facts and doctrines of the science. It is divided into two parts: "Geology inductively presented," and "Geology treated systematically." Geology is the science which treats of the earth; the earth is under our feet; let us, therefore, the author says, "direct our attention to it, and see what facts may be observed. These will be geological facts. Every fact learned by observing the earth is part of the science; and the things observed near home are just as real science and just as important as those in distant lands, of which we may read in the books." The drift being nearly everywhere, the reader is invited to make that the special subject of his study. He will find in it representations of a great variety of geological phenomena and formations, minerals and fossils. He can make the facts he learns from it the basis of his more extended studies in excursions, or in books, after he has well traversed the field in which he is able to make excursions. The outcome of the first, or inductive, part of the book, in which the course is carried far enough to illustrate how to study fossils in a scientific way, "is a somewhat chaotic and undigested mass of facts and doctrines buried in a considerable volume of verbiage. It does not assuredly supply the means for a methodized apprehension of the elements of the subject, but it supplies many fundamental facts, many great principles, many impressions, many hints for personal observation, and many impulses to continue. Far better for the student to get so much than to leave school in total ignorance of a science which sustains so important relations to industries, to culture, and to civilization. Part II is the complement of this. Here the whole body of facts and principles is reduced to a methodical representation. . . . Here, too, the discussions of the several topics are completed, and the various portions are adjusted to a logical relation." The book treats principally of American geology, and in this all the recent additions, which have transformed the science so that "the subject has to be treated very much as if no elementary book had been written," have been made use of. The motto of the first part is, "How we may observe the facts, and learn their meaning." The successive chapters of the second part, which are divided into many special sections, treat of "lithological," "structural," and "dynamical" geology, the "progress of terrestrial life," and "formational" and "historical" geology.

Guide to the Recognition of the Principal Orders of Cryptogams, and the Commoner and more Easily Distinguished New England Genera. By Frederick Leroy Sargent. Cambridge (Mass.): Charles W. Sever. Pp. 78.

This book was prepared for the use of students in the summer course in botany at Harvard University, in which the author is

a teacher. It is intended to present the distinctive characteristics of the genera of the family, which are not described in the usual text-books, with sufficient compactness for easy use in field-work. The attempt has, therefore, been made to bring together, in systematic form and a convenient shape, such information as would enable a student to learn to recognize a number of the more conspicuous genera. Half of the leaves are left blank for the convenience of students wishing to insert notes and sketches.

History of California. By Hubert Howe Bancroft. Vol. IV. San Francisco: A. L. Bancroft & Co. Pp. 786. Vol. V. San Francisco: The History Company. Pp. 784.

The fourth volume continues the history as to general affairs from 1836, and as to local affairs from 1840 to 1845. The story of the secularization of the missions is carried on. Among other topics of interest, the doings of foreigners, American occupation, the "Graham affair," the coming of Sutter, and the establishment of New Helvetia, are treated in a new light. The career and character of Sutter—whose story is closely connected with the awakening of the gold-fever and the occupation of the country by American miners—are reviewed in full. This man hardly appears here as the public-spirited citizen which many have been disposed to regard him, but as a reckless adventurer and speculator. The records of the several overland immigrant parties are given, beginning with the Batterson or Bidwell party, in 1841, and including the companies of Workman and Rowland in the same year; of Hastings, Chiles, and Walker, in 1843; of Fremont, Kelsey, and Stevens, or Murphy, in 1844; and of McMahon and Clyman, Swasey and Todd, Sublette, Grigsby, and Ide, Fremont and Walker, and Hastings and Semple, in 1845; also accounts of Commodore Jones's achievements in 1842, of the Russians who left California in 1841, the Hudson Bay Company's branch in San Francisco, the fur-hunters' operations in the interior, and the trading-caravans from New Mexico. Prominent among the topics of foreign relations are the schemes of France, England, and the United States, to gain possession of California; and particular attention is given to the plans and efforts of the United States and its agents, as shown in original correspondence, now given to the public for the first time; and the treatment of American immigrants down to 1845 is set forth.

The fifth volume comprises—from 1846 to 1848—the exciting period of the conquest of California by the United States, which is treated in all its phases. The policy of our Government and the doings of its agents are studied from documentary sources not hitherto brought to light. Hence the volume is likely to prove, as a narrative, more interesting and readable than any that have preceded it; and it can not fail to be important as a record, because it is founded largely on original testimony. Its contents embrace, first, the acts of Fremont in the country, which are set forth in an unfavorable light; next, the personal and sectional controversies that marked the last days of Mexican political annals. A following chapter is devoted to foreign relations, the policy of the United States and other nations, and the efforts of Colonel Larkin; another chapter to the causes of the settlers' revolt, wherein Fremont is again handled with severity; and four chapters to the detailed presentment of the "Bear Flag" revolt; after which begins the story of the conquest proper as part of the Mexican War. This having been told, the political controversies of Stockton, Kearney, and Fremont, next claim attention. The stories of the Mormon Battalion, the New York Volunteers, and the Artillery Company, are given; also the annals of immigration, including the tragic experiences of the Donner party and the coming of Sam Brannan's Mormon colony; the history of the ex-missions and of Indian affairs, with the annals of trade, and other incidents, going to complete the history. The pioneer list is completed, and includes in all some ten thousand names and biographical sketches. Our heading indicates a change in the name of the publishing house. A story is connected with the change. The whole establishment was burned down last April, with an inadequate insurance. Mr. H. H. Bancroft was the principal proprietor, and lost very heavily, not only through his share in the

business, but also in the destruction of the plates of nine volumes of the history, and of the whole edition of the first volume of the "Oregon." In rebuilding and reorganizing the concern, it was necessary to dispose of a part of the business. Mr. Bancroft, having determined to devote his life to the history, resolved to sacrifice all to that. Hence the new concern is formed as "The History Company," and its peculiar work till that is done will be to bring out this "History."

Physical Training in American Colleges and Universities. By Edward Mussey Hartwell. Washington: Government Printing-Office. Pp. 183, with Plates.

This is one of the "Circulars of Information" of the Bureau of Education, and is published at the request of the commissioner. Dr. Hartwell makes a comprehensive and satisfactory presentation of the subject. He begins with a sketch of the "ideals of manly excellence" and a running history of gymnastic training down to the time of Fellenberg and the Hofwyl schools; then describes the "Introduction of Gymnastics into America," from the starting of the Fellenberg schools in 1824 and 1825; relates the development of the "New Gymnastics," and records the history of the building of gymnasia in colleges. The particular accounts of the principal college gymnasia and gymnasia of the Young Men's Christian Associations are illustrated with views and plans of buildings. Tables are given exhibiting the facts that twenty-six colleges in the United States have buildings exclusively devoted to gymnastic purposes, the cost of which, including fittings, is estimated at $750,000; and twenty other institutions have gymnasium or drill-halls. Nine theological schools also have gymnasia. During the year ending July 1, 1884, thirty-three officers of the army were detailed to duty at colleges, universities, and schools of superior instruction to young men, for giving military drill. College athletics have been most developed in the East, and particularly at Harvard, Yale, and Princeton. At most country colleges ample facilities in the way of grounds are furnished for the playing of base-ball, foot-ball, and tennis; and since track athletics, or walking, jumping, sprint and hurdle races, have become popular, very considerable sums have been spent on the grading and improvement of athletic fields. "Exhibitions and contests of every description which would not have been licensed or tolerated, much less pecuniarily supported, thirty years ago, now yield quick and large returns in popularity and cash to their promoters." On the subject of college athletics, the report draws largely upon the article of Professor Richards in "The Popular Science Monthly" for February and March, 1884, which is pronounced "the fairest and most intelligent paper elicited by the recent discussion of athleticism which has come under our notice," and one in which "the whole system is so well set forth, its advantages are so cogently argued, and the attacks of its critics so temperately met, that it seems best to quote copiously from it. Its exposition of the reciprocal relations of body-work and brain-work should be grasped by every teacher." But professionalism, defined as "the purpose to win a game by any means, fair or foul," has come in to bring discredit upon college sports, and make recognition and regulation of them by faculties necessary; and what has been done and attempted in this direction is reviewed. Women's schools and colleges are not, as a class, so well organized on the side of physical training as those for men, but something has been done in a few of them, and the Association of Collegiate Alumnæ is laboring to awaken interest in the subject. A sketch of the condition of physical training in Germany forms an appendix to the report.

Report of a Commission appointed to consider a General System of Drainage for the Valleys of Mystic, Blackstone, and Charles Rivers, Massachusetts. Boston: Wright and Potter Printing Company. Pp. 243, with Plates and Maps.

The commission was appointed in 1884 to consider and report a general system of drainage for the relief of the valleys of the rivers named, and for the protection of the public water-supplies of the cities and towns situated within their basins; also to examine the various methods of disposal of sewage. And it was further authorized to consider and report upon the needs of any

other part of the Commonwealth as to the disposal of sewage and the protection of the public water-supplies therein. Its report is a carefully matured and valuable document, in which the subject is viewed under its various aspects, and results are given that may aid in forming judicious conclusions wherever problems of sewage disposal may present themselves. The bulk of the volume is given to the report of the engineer of the commission, Mr. Clarke, who first defines the problem in its general and detailed features, gives an account of all the elements that contribute to stream pollution in each town, the manner and present expense of dealing with a part or all of the objectionable matters, and refers to what actions have been taken or what opinions have been held by the local authorities on the subject. In a second part of the report he presents the general conclusions arrived at, in England and elsewhere, as to the best methods of sewage disposal under conditions similar to those of Eastern Massachusetts. This part is illustrated with particular accounts of the operation of the methods by filtration, irrigation, precipitation, etc., which are used in various towns in England, and photographic views. In the third part the conclusions with reference to methods are applied to each particular locality in the district whose needs are to be provided for. Among the engineer's conclusions is the hopeful one that manufacturers, as a class, are very intelligent, and there is no limit to the ingenuity they have displayed in devising processes and machinery for accomplishing desired ends. This ingenuity hitherto has not been directed toward purifying their refuse, because such purification has not been considered necessary. The mechanical problems involved are not so difficult but that they probably can be solved, if only intelligent efforts and experiments are made in that direction. As an offset to this is the fact, not so encouraging, that "it is much easier to design a proper system of sewerage than to remedy the defects of one already constructed. Indeed, thoroughly to do the latter is well-nigh impossible. Unfortunately, the sewers in many towns of the State have been built piecemeal and without any system. First, a single drain is built, chiefly to remove surplus rain-water. It discharges little or no sewage, and the pollution of the outlet is thought to be unimportant. House-drains are afterward connected with it, so that it assumes the functions of a sewer. Then another branch sewer connecting with it is built, and from time to time more are added. So a network of pipes grows up, without system, and without adaptation of one pipe to the others. The sewers work badly, and the amount of sewage discharged at the outlet begins to make a nuisance. Then, perhaps, but not before, some expert in sewerage is called into consultation. It is, however, too late—the mischief has been done—and he rarely can suggest any but palliative measures, unless the town is willing to abandon all of the work already done, and begin again *de novo*. Many nuisances and much expense would be avoided if it were required in the future that no towns should be allowed to build sewers except such as formed parts of a well-digested scheme for the whole town; which scheme provided for the proper disposal of the present and prospective amounts of sewage, and had first been submitted to, and approved by, some experts appointed by the State. The same principle applies to manufactories."

The Science of Business. By Roderick H. Smith. New York: G. P. Putnam's Sons. Pp. 182.

The author presents this essay as "a study of the principles controlling the laws of exchange." He believes that the course of business is governed by fixed natural laws, and that those laws correspond, as it were, with the law of motion, which goes along the line of least resistance, and is also subject to the law of rhythm. By the latter law, the ups and downs of business are regular in their recurrence, or periodical. No attempt to account for commercial fluctuations can be successful that loses sight of this. We may assign what particular causes may be most apparent for the stimulation of speculative movements or for the prevalence of failures. They may all have their influence; but that influence works in with the rhythmic movement, not against it or independently of it. The author calculates

the period of the rhythmic wave to be about ten or eleven years; and according to his computations the period of depression in which we are now supposed to be sinking is to culminate in 1887. Curiously enough, he predicts—it was a prediction when he wrote it—that "during the years of depression into which we are now entering—1885, 1886, 1887—we may expect numerous strikes, mobs, and troubles in our cities among laboring classes, incident to such times." While Mr. Smith's theory must be classed in the long list of hypotheses very much in need of proof, it is fair to say that he does not write like a wild visionary, but in the manner of a capable man who has thought long and earnestly upon the question he discusses.

The Fitting-Schools. By G. von Taube. New York: Gramercy Park School and Tool-House Association. Pp. 86.

The author is the originator and present director of the Gramercy Park Tool-House, and considers in this pamphlet the educational methods followed there—which attempt considerably more than simply to introduce the tools, or to train a future mechanic. From the statements of his theory of education we cite this about the primary work, or purpose, of the Kindergarten, which "is generally accomplished, *notwithstanding* the school. The early culture of perceptions goes ahead according to Nature's rules, even if the A B C remains unmastered. And facing the fact that a great deal of the very Kindergarten work is not wisely (we should say philosophically) arranged and conducted, we are obliged to come to the conclusion that the knowledge how to lose time wisely is the best maxim to be followed at an early age of the child. What has to be attended to is the discipline of habits, that of steady preoccupation, a concentration of attention leading to future thoroughness. Then the habit of neatness, that of sociability, the early sympathy toward a sufferer, a good, square, friendly acquaintance with Mother Nature's objective department. . . . Thus the creation of a good motive in children depends greatly upon careful early management, and the spontaneous activity of the little ones is made available to that effect." Arriving at the age of generalizations the study is directed toward new and wider subjects—a higher analysis of life and its conditions. In the conclusion—"Education, let us believe, is a specialty, is a serious study; not a personal opinion on a light subject, but a generalization, the inductions of which extend through centuries, whose truths call for testimony of most mixed sciences. Education, therefore, as a science, can no more be mixed up with emotional ventures and declamations than physics, chemistry, or astronomy. The future of a generation, embodying the dearest we possess on earth—our children—is too serious a matter to be settled off-hand, or to be indiscriminately and blindly deduced from a few principles, even if these should be of the highest kind."

Anthropophagy, Historic and Prehistoric. By General Charles W. Darling, Utica, N. Y. Privately printed. Pp. 47.

The author, in his readings relating to the origin and history of the human family, was impressed with the frequent allusions to man-eating among many of the peoples of the world, and was prompted to collate some of the references to the custom, in a connected form. In doing this, he has endeavored to be faithful to the facts as related by historians and travelers. His record begins with the Cyclopes of the Greeks, and ends with the distressing incidents of the Greely Expedition.

Proceedings of the Sixth Meeting of the Society for the Promotion of Agricultural Science. 1885. B. D. Halsted, Secretary, Ames, Iowa. Manhattan, Kansas: State Agricultural College. Pp. 59.

The society was organized in 1880, for the purpose of bringing together those who are interested in the applications of science to agriculture, discussing the methods and results of investigations, and providing for publications relating to the same. The present meeting was held at Ann Arbor, Michigan. Among the papers recorded in the report are—"The Vitality of Seeds buried in the Soil," by W. J. Beal; "The Demands made by Agriculture upon the Science of Botany," by Charles E. Bessey; "On Some Redeeming Traits of Alkali Soils,"

by E. W. Hilgard; "An Investigation of the Origin of the Dandelion," by E. L. Sturtevant; and an account of some experiments on "Variation in Cultivated Plants," by W. W. Tracy. In his observations on the last subject, Mr. Tracy finds many illustrations of variations of type which cultivators had been trying to produce for years, appearing in different localities and from different stocks at about the same time, so as to seem to indicate that variation is not an accident, but a progression of the species.

The Journal of Physiology. Edited by Michal Foster and others. Vol. VII, No. 1. Cambridge Scientific Instrument Company's Works, Cambridge, England. Pp. 80. Price, $5 a volume, of four numbers.

We notice this "Journal" at the beginning of its new volume, because it is one of the principal recognized mediums through which original investigators in physiology make known the results of their work. Research in this branch of science is now very active, and is distinguished by minute attention to details. It is the custom of the "Journal" to publish the particular accounts of the experiments and conclusions of investigators, with a fullness and excellence of pictorial illustration that leave nothing to be desired. Professor Foster, as editor of this publication, is assisted in England by Professor W. Rutherford, of Edinburgh, and Professor J. Burdon-Sanderson, of Oxford; and in America by Professor H. P. Bowditch, of Boston; Professor H. Newell Martin, of Baltimore, and Professor H. C. Wood, of Philadelphia. The present number is occupied with a paper by W. H. Gaskell, "On the Structure, Distribution, and Function of the Nerves which innervate the Visceral and Vascular Systems."

Science and the State. By R. W. Shufeldt. Pp. 10.

Dr. Shufeldt advocates patronage of science by the Government, and argues that it must be a good thing because the Government already fosters some dozen or more scientific bureaus at its seat, and they are all thriving. He would extend the scope of these bureaus, and the patronage of the Government, and would have organized at Washington a Department of Science, with buildings and a dozen sections, and a Cabinet officer—the Secretary of Science—to preside over the whole. The "Monthly's" opinion of schemes of this kind and its reasons for holding it have been often enough and plainly enough expressed, and need not be repeated. Happily the author—although his reference is to officers of the army and navy already in Government employ having a taste for science overruling that for their real business—has made a very terse statement of the real attitude which the Government should occupy toward scientific students. It is that it "should offer the constant opportunity to such men to do the work for which they were born, molded, and designed, but allow them to do it in their own way, at their own times, and absolutely unhampered by any but the most necessary regulations." This maxim may apply to officers in time of peace, when the corps are kept up merely for the sake of having them on hand. Broadened, and with the addition of "at their own expense or that of their friends," it would make a most excellent rule of universal application, and would convey the true doctrine.

The Country Banker: his Clients, Cares, and Work. By George Rae, with an American Preface by Brayton Ives. New York: Charles Scribner's Sons. Pp. 320. Price, $1.50.

This work, eminently practical in its teachings, presents the results of forty years' experience in banking. Its purpose "is not to formulate afresh the fundamental principles of banking, but rather to show those principles in operation; to exhibit, so to speak, the machinery of banking in motion; . . . less to advance special views of my own, than to exemplify, from fresh points of observation, the accustomed lines and recognized limits of prudent banking." The epistolary form is used—the author taking the position of a person writing instructions to the manager of the bank—because it gives scope to a more familiar treatment of the subject, with such success that Mr. Ives is able to say, in his preface to the American edition, that the book is a notable exception to the admitted rule that the average writer on financial subjects lacks the ability to treat them in an attractive manner. "Without being pedantic, or too

technical, the author has written a book which is so admirable in style that it presents strong claims to public attention, viewed solely from a literary standpoint. . . . The author's experience of thirty-five years in a bank did not convert him into a machine, nor make him unmindful of everything except money-getting. Out of banking hours he must have read many good books, and thought carefully over their contents. We find everywhere signs of his keen knowledge of human nature. He recognizes and demonstrates the fact that successful bankers must have some, at least, of the cardinal virtues; that they must be courteous, honorable, prudent, and industrious."

Industrial and High Art Education in the United States. By I. Edwards Clarke. Washington: Government Printing-Office. Pp. 1100.

This volume is part of a report on the subject described in the title made by the author to the United States Commissioner of Education. The report complete will include four volumes. The particular branch of the subject here discussed is "Drawing in Public Schools." The object sought in the preparation of the report, as stated by the author, has been to place in the hands of educators and educational officers "the material not only for forming an intelligent judgment upon the advisability of introducing the study of drawing into the public schools, but also, as well, to furnish the facts needed for a like consideration of the questions arising in regard to establishing special schools of technical industrial art training, high art academies, public art museums, art libraries, and of making occasional public loan exhibitions." The volume is in two parts; the report and the appendices, besides an introductory chapter. The report also is in two parts. The first part consists of fourteen "original preliminary papers," occupying 258 pages, "suggesting the direct and indirect relations of art to education, to industry, and to national prosperity," which are grouped under the general heading of "The Democracy of Art." In the second part, of 411 pages, the subject is considered, historically, with respect to England and America (particularly Massachusetts), to the present position of drawing in several States of the Union, and to concurrent contemporary testimony concerning drawing in the public schools. The appendices contain papers relating to early efforts to introduce drawing as a branch of popular education, in the United States and in England; to the origin, development, and purpose of industrial art education; to the management of the Massachusetts State Normal Art School; to the Industrial Art-training Exhibits in the Centennial Exhibition; to Governmental Aid to Education in the Industrial and Fine Arts in Great Britain; to Industrial Education; and to the International Conference on Education, held in London, in August, 1884. The preparation of the report was begun in 1877, or of a part of it, as indicated in one of the statements, as far back as 1874. The work has since been added to several times, but not, apparently, revised; in fact, the author acknowledges that he considered the task of rewriting it a hopeless one, and adopted in preference, as a more feasible plan, "in adding the new matter to leave the history as previously completed, and under the head of 'addenda' to proceed with the subsequent statements." In several instances the "addenda" are far longer than the history to which they are attached. Thus, the report has come to answer, with unusual accuracy, to the author's own description of it as resembling "one of those vast, rambling, mediæval structures to which succeeding ages have builded additions as the needs or tastes of new generations impelled." It contains a great deal of valuable matter, that could have been put, in vastly better shape, in a fraction of the space the present volume occupies. Then we should have had a compact, manageable book, written to the point, which publishers would have competed for the privilege of putting on the market. As it is, it is a striking re-enforcement of our argument against the Government going into the publishing business.

Annual Report of the Connecticut Agricultural Experiment Station for 1885. Middletown. Pp. 139.

The analysis of commercial fertilizers and work connected with the collection, examination, and valuation of samples have occupied the larger part of the time of the station's working force. One hundred and thirty-nine brands of fertilizers were legally

sold in the State during the year, and one hundred and seventeen other analyses of fertilizers of various kinds were made. Other analyses or tests were made of feeding-stuffs, seeds, milk, well- and spring-water, and soils, and cases of suspected poisoning of animals were inquired into. Four bulletins were published, and sent to the post-offices for distribution to agricultural societies and clubs, to newspapers, and, on application, to private addresses; and hektograph copies of analyses are liberally sent out as soon as the analyses are finished.

Old School Days. By Amanda B. Harris. Chicago and Boston: Interstate Publishing Company. Pp. 109, with Plates. Price, 60 cents.

This is a vivid reproduction, from memory, of days and scenes and customs that have passed away, and live only in the traditions of those who are now fathers and mothers. It brings before us the New England country school-house of forty or fifty years ago, with the children plainly dressed, and most of them barefooted. The story can not fail to be pleasing to those who would recall the days when they were children, and to those who would enjoy a representation of what their parents did and saw in the school.

The Great Conspiracy; its Origin and History. By John A. Logan. New York: A. R. Hart & Co. Pp. 810.

This book will attract attention on account of the author's prominence in the politics of the day, and will particularly interest those who recollect his activity as a soldier of the Union during the war of the rebellion. In preparing the book it has been his aim, he says, "to present in it, with historical accuracy, authentic facts; to be fair and impartial in grouping them; and to be true and just in the conclusions necessarily drawn from them. While thus striving to be accurate, fair, and just, he has not thought it his duty to mince words, nor to refrain from 'calling things by their right names'; neither has he sought to curry favor, in any quarter, by fulsome adulation on the one side, nor undue denunciation on the other, either of the living or of the dead"; in treating the subject, "he has conscientiously dealt with it, throughout, in the clear and penetrating light of the voluminous records so readily accessible at the seat of our national government. So far as was practicable, he has endeavored to allow the chief characters in that conspiracy, as well as the Union leaders, . . . to speak for themselves, and thus, while securing their own proper places in history, by a process of self-adjustment, as it were, themselves to write down that history in their own language." Nevertheless, the style of the book is warm; and many of the thoughts and expressions seem more appropriate to a period that survives only in history than to the present, when men's thoughts are running in other channels, and their controversies are on other questions than those that engaged exclusive attention twenty years ago.

Smithsonian Accounts of Progress in 1885. Washington: Government Printing-Office.

Geography. By J. King Goodrich. Pp. 36.—Mr. Goodrich has given a very readable account of the year's work in geography, which others than special students of the subject will be interested in. Beginning with "general notes" relating to the condition and growth of geographical knowledge as a whole, he arranges his review under the special headings of the several regions which have been fields of geographical research, with accounts of the work done in each.

Chemistry. By Professor H. Carrington Bolton. Pp. 50.—This account, though short, gives the record of a busy year's work, in which, while no startling discoveries have been made, a great deal has been done in the study of important questions relative to the nature of the chemical radicals, their relations to one another, and their reactions.

Vulcanology and Seismology. By Charles G. Rockwood, Jr. Pp. 23.—The study of this branch is still devoted largely to individual manifestations, with much inquiry for laws and causes, but few definite general conclusions. It is given here as one of the conclusions of Verbeck's investigation of the great Krakatoa eruption, that that volcano lies at the intersection of three fissures of the earth's crust, and the earthquake of September 1, 1880, probably affected the Sunda fissure and facilitated the entrance of great-

er quantities of water to the volcanic furnace beneath. Hence the remote causes of the outburst of 1883.

Physics. By Professor George F. Barker. Pp. 60.—Besides the results in general physics, Professor Barker mentions the studies that have been made in the physics of liquids and gases, light, acoustics, and electricity, and special applications.

Mineralogy. By Professor E. S. Dana. Pp. 26.—The subject is considered under the headings of "General Works on Mineralogy," "Crystallography and Physical Mineralogy," "Chemical Mineralogy," "New Mineral Localities in the United States and elsewhere," and "New Minerals."

Anthropology. By Professor Otis T. Mason. Pp. 56.—This account includes considerable technical matter; but we find in it sections on the ethnology of the American aborigines, and on the glossology, comparative technology, sociology, and mythology and folk-lore of our tribes.

Astronomy. By William C. Winlock.—Mr. Winlock works as a substitute for Professor E. S. Holden, whose manuscript review, already prepared, was lost in removing his library. Faye's "Cosmological Theory," and G. H. Darwin's review of it, new discoveries of nebulæ, investigations of astronomical constants, recent star catalogues, studies in parallax, in variable, new, or temporary stars, in stellar spectra, proper motions, and photometry, astronomical photography, what has been done and said about comets, the studies of Langley and others on the sun, and of other astronomers on various planets, receive attention.

Zoölogy. By Professor Theodore Gill. Pp. 53.—The continued tendency toward the special study of embryology, and of animals from an embryological point of view, is remarked upon. At the same time systematic zoölogy has at least maintained its course. Particular mention is made of Dr. Boulenger's catalogue of the lacertilian reptiles in the British Museum, Professor Cope's "Tertiary Vertebrata," and Professor Marsh's "Dinocerata." The subject is reviewed according to the various groups of the animal kingdom in which memoirs have appeared.

North American Invertebrate Paleontology. By John Belknap Marcou. Pp. 47.—Mr. Marcou gives summaries of the various monographs that were published during the year, the whole furnishing a fair and tolerably full representation of what was accomplished. All of these reviews, except the "Geography" and the "Paleontology," which is itself a bibliography, add bibliographies of their subjects, and necrological notices. In Professor Gill's zoölogy the bibliographical notices are given in the text according to the groups to which the subjects belong.

PUBLICATIONS RECEIVED.

The Interstate Readers. Primary, pp. 32; Intermediate, pp. 32. Price of each, 30 cents for ten numbers. Grammar-School, pp. 48. 15 cents a number. All monthly, and No. 1, September, 1886. Chicago and Boston: Interstate Publishing Company.

The Irish Question. By the Right Hon. W. E. Gladstone. New York: Charles Scribner's Sons. Pp. 57. 10 cents.

The Relation of Hospitals to Medical Education. By Charles Francis Withington, M. D. Boston: Cupples, Upham, & Co. Pp. 47.

Report of the Iowa Weather Service. 1883. By Dr. Gustavus Hinrichs, Director, Des Moines. Pp. 208.

Bulletin of the Buffalo Society of Natural Sciences. Vol. V, No. 2. Pp. 52, with Plate.

Report of American Association Committee on Indexing Chemical Literature. Pp. 7.

Catalogue of Rutgers College, at New Brunswick, N. J. 1885-'86. Pp. 66.

Function: Its Evolution and Influence. By C. N. Pierce, D. D. S. Philadelphia. Pp. 7.

A New Philosophy of the Sun. By Henry Raymond Rogers, Jamestown, N. Y. Chautauqua Society of History and Natural Science. Pp. 27.

The Manifesto. August, 1886. Henry C. Blinn, editor, Shaker Village, N. H. Pp. 24.

The Silver Question. By E. J. Farmer, Cleveland, Ohio. Pp. 12.

Michigan State Board of Health. Report of Proceedings. July 13, 1886. Pp. 13.

The Botanical Gazette. John M. Coulter, Charles R. Barnes, and J. C. Arthur, editors. Monthly. Crawfordsville, Ind. Pp. 36.

Kupfer in den Vereinigten Staaten (Copper in the United States). By E. Reyer, Vienna, Austria. Pp. 10.

The Menorah. Monthly. Benjamin F. Peixotto, editor. New York: No. 39 Broadway. Pp. 48.

The Hygiene of Nature. By Dr. Romaine J. Curtiss, Joliet, Ill. Pp. 18.

Architecture, Heating, and Ventilation of Institutions for the Blind. By J. F. McElroy, Adrian, Mich. Pp. 21.

Edison's Incandescent Electric Lights for Street Illumination. By A. Hickenloper. Cincinnati: Robert Clarke & Co. Pp. 95. 50 cents.

Duffy's Wave-Motor as a Source of Power, etc. San Francisco: Terence Duffy. Pp. 15.

The Second Law of Thermodynamics. By Professor J. Burkitt Webb. Salem, Mass.: The Salem Press. Pp. 14.

The Heart of the Fish, compared with that of Menobranchus, with Special Reference to Reflex Inhibition and Independent Cardiac Rhythm. By T. Wesley Mills. Montreal. Pp. 11.

C. V. Riley. Report of the Entomologist of the Agricultural Bureau for 1885. Pp. 160, with Plate. The Mulberry Silk-Worm. Pp. 61, with Plate.

The Financial Problem: Its Relation to Labor Reform. By Alfred B. Westrup. Dallas, Texas. Pp. 32.

Ophthalmoscopic Examination of the Insane. By Louis J. Lauterbach, M. D. Philadelphia. Pp. 4.

Exploration of the Marriot Mound. Ohio, No. 1. By C. L. Metz and F. W. Putnam. Pp. 18.

Rutgers Scientific School. New Brunswick, N. J. Twenty-first Annual Report. Pp. 61.

List of Institutions in the United States receiving Publications of the Smithsonian Institution. Washington. Pp. 72.

Resultados del Observatorio Nacional Argentino (Results of the Argentine National Observatory). Juan M. Thome, Director. Buenes Ayres. Pp. 564.

Cassell's National Library. No. 28. Sir Roger de Coverley and the Spectator's Club. No. 29. Voyages and Travels of Marco Polo. No. 30. Merchant of Venice. By William Shakespeare. No. 31. Religio Medici. By Sir Thomas Browne, M. D. Pp. 192 each. 10 cents each.

Practical and Analytical Chemistry. By Henry Trimble. Philadelphia: P. Blakiston, Son, & Co. New York: E. R. Pelton. Pp. 110. $1.50.

The Optimism of Ralph Waldo Emerson. By William F. Dana. Boston: Cupples, Upham, & Co. Pp. 64. 50 cents.

Astronomy by Observation. By Eliza A. Bowen. New York: D. Appleton & Co. Pp. 90, with Plates. $1.

Aphrodite. By Ernst Eckstein. From the German by Mary J. Safford. New York: William S. Gottsberger. Pp. 289.

The Millennial Dawn. Vol. I. The Plan of the Ages. By Charles T. Russell. Pittsburg: Zion's Watch Tower. Pp. 351.

First Lessons in Zoölogy. By A. S. Packard. New York: Henry Holt & Co. Pp. 290. $1.

The First Three Years of Childhood. By Bernard Perez. Chicago: A. N. Marquis & Co. Pp. 292. $1.25.

Hand-Book of Mineralogy. By J. C. Foye. New York: D. Van Nostrand. Pp. 180. 50 cents.

Selections for Written Reproduction. By Edwin R. Shaw. New York: D. Appleton & Co. Pp. 102. $1.

The Jugurthine War of C. Sallustius Crispus. Edited by Charles George Herbermann. New York: D. Appleton & Co. Pp. 272. $1.12.

The Earth's Annular System. By Isaac N. Vail. Cleveland, Ohio: Clark and Zangerle. Pp. 400. $2.

Numbers Applied: A Complete Arithmetic. By Andrew J. Rickoff. New York: D. Appleton & Co. Pp. 416. 75 cents.

Forest Commission of the State of New York. First Annual Report. 1885. Albany. Pp. 362.

United States Commission of Fish and Fisheries. Report for 1883. Pp. 1206, with Plates.

United States Entomological Commission. Fourth Report on the Cotton-Worm and Boll-Worm. By Charles V. Riley. Washington: Government Printing-Office. Pp. 147, with Plates.

Elements of the Comparative Anatomy of Vertebrates. Adapted from Robert Wiedersheim by Dr. W. Newton Parker. London and New York: Macmillan & Co. Pp. 345. $3.

The Logic of Introspection. By the Rev. J. B. Wentworth. New York: Phillips & Hunt. Pp. 446.

Report upon the Third International Geographical Congress and Exhibition at Venice. By Captain George M. Wheeler. Washington: Government Printing-Office. Pp. 586.

POPULAR MISCELLANY.

Niagara Falls at the American Association.—Professor Pohlman presented his theory of the origin of the Niagara gorge to the American Association at its recent meeting. This theory differs essentially from the views usually accepted by geologists, that Niagara Falls were originally at Lewiston, and the river has since excavated the chasm through which it flows, thence to the present position of the falls. Professor Pohlman's view is based on a careful survey of the district appertaining to the Niagara basin, which he distinctly defines, with its ancient river-beds, and of the ancient beach-marks on the lake-shores that testify to the gradual subsidence of the water. It supposes that the ancient Tonawanda River flowed into the valley of the present Niagara at about the same place as where it enters now; that the original point of overflow of its waters across the thin-bedded Niagara limestone was perhaps somewhere near or a little southerly from the upper rapids at the present falls; that from here the waters met no obstacle, and in their flow predetermined the river-gorge between the falls and the Whirlpool, and continued in a straight course north through the valley of St. Davis. They descended over the escarpment at the latter place, and along this line in the course of time the three falls over the Medina sandstone and the Clinton and Niagara limestones were formed. During the glacial period the natural drainage-lines were closed up, and a great lake was formed. After the disappearance of the ice-sheet, when the water had subsided to about 605 feet above the ocean, or stood on a level with Lewiston Heights, Lake Erie and Lake Ontario formed two large bodies of water, separated by a mud-flat which extended from Buffalo to Lewiston. Then, as Professor Pohlman attempts to show from the terraces, the two lakes drained simultaneously, and were connected by a river with a more or less swift current, but without any fall, simply deepening its bed in the drift and shaping its course along the buried pre-glacial valleys. But, when the waters reached the Niagara limestone at the edge of the Lewiston escarp-

ment, the current of the river was broken by rapids; for the thin layer of limestone which here overhangs the Niagara shale would barely be strong enough to sustain the tremendous volume of water and form a fall over its edge. The rate at which the gorge was excavated between Lewiston and the Whirlpool must have been rapid. The route was predetermined by a shallow valley, which had reduced the upper layer of limestone to a considerable extent. Thus there was never a fall at Lewiston, only a series of rapids drawing back to the Whirlpool, where the falls were started and whence only, and not from Lewiston, they have receded.

Professor R. S. Woodward, of the United States Geological Survey of the Falls, presented a report on the rate of recession, which he computed to be about 2·4 feet a year, or a mile in 2,300 years. Mr. G. L. Gilbert, also of the United States Geological Survey, gave an account of his observations of the lake-shore terraces, and the conclusions he had drawn from them respecting the subsidence of the lakes. Taking up Professor Woodward's estimate of the rate of recession of the falls, he remarked that it would make the work of excavation extend over 7,000 years. This was subject to various qualifications by channels of earlier origin, by different rocks of different thickness encountered from time to time in the wearing away process, and by the difference in the volume, breadth, and plunge of the river at various periods of its history. On the whole, he was inclined to the opinion that the estimate of 7,000 years should be regarded as a maximum. After one or two other speakers had taken part in the discussion, Professor Pohlman said that he was glad to find the "mountains of science" agreeing with "a mole-hill like himself" regarding the existence of a pre-glacial valley. Professor E. W. Claypole, in a paper on the "What might have been" of Buffalo and Chicago, showed that if the ice-barrier at Buffalo had been twenty-five feet higher than it was, or had the Mackinaw channel been freed from its barrier before the outlet from Lake Erie and Lake Ontario was unlocked, the drainage of the four lakes would have been reversed; the Mississippi would have taken the place of the St. Lawrence, Chicago of Buffalo, and Buffalo of Chicago.

An Æsthetic View of Polygamy.—Mr. George Ticknor Curtis, in his argument in the Supreme Court of the United States in the case of Lorenzo Snow, plaintiff in error, takes a view of Mormon polygamy that we do not remember to have before observed to be insisted upon in the States. By this view the relation to all but a single wife is purely spiritual, and one simply of care-taking, with recollections only of past more intimate ties. The idea of it is given in the testimony of Harriet Snow, who was married to Snow in Nauvoo in 1846, and had never been divorced. She said: "He was not my husband in 1884, according to the general term of husband. He did not live with me as a wife. He had arranged for my support, and I drew it as common. In 1884 I looked upon him as my companion, the husband of my youth. In 1884 the marriage relation did not continue as it was in my young days. I was an old lady in 1884. I call myself a married lady. I was sealed to the defendant for time and for eternity. When a lady gets so that she can not bear children, then she is released from some of her duties as a wife. I mean that he is my companion, but not husband." According to Mr. Curtis's argument, Snow had duties to discharge toward Harriet and the other women similarly situated toward him, which duties, the attorney continues, "are natural, are of moral obligation, of perpetual obligation, and are duties which, when we consider how and when they were assumed, and how they have become woven into the texture of his life, it would be barbaric to punish." The question is, in fact, surrounded with more and greater embarrassments than the urgers of summary legislation to put down polygamy have apparently been ready to consider. The women, who profess to have acted conscientiously, are entitled to protection and provision whatever laws may be enacted. They have a right to be placed where they can be supported and can live respectably. The problem is one of the same kind as that which troubles Christian missionaries when they make converts in polygamous countries,

and which so dignified and able a body as the Convocation of Canterbury has this year substantially confessed itself unable to solve. It is really more complicated than this; for the condition among the Mormons is one that has grown up under our own neglect and tolerance, while we might have met it in the beginning and prevented its development if we had had the nerve to do so.

Inherited Memories.—Dr. H. D. Valin has communicated to "Mind in Nature" (Chicago) some instances in which specific memories appear to have been transmitted by inheritance. He believes that they are the first cases that have been published, for even Ribot confesses to have had but little success in establishing instances of the kind. The most striking case is that of a little girl fifteen months old, the child of a French Canadian father, whose principal traits of character and appearance she seems to have received, and of an American mother of German descent. She has had only the English and German languages spoken to her; yet the first word she ever spoke—when five months old—was *mouman*, the French Canadian form of *maman*, mother. Her first words of assent and dissent were *oui* and *non*—French—when eight months of age, "and she does not yet know *yes* or *ya*, though she seems to have forgotten *oui*. When a year old she was presented with a poodle-dog named Venus, which she called *Nanan*—candy, "one of the very first words that a French child talks." At about the same age she used freely the words *bon*, good, and *pus*, French Canadian for *plus*, no more. These six French words are the very ones that her father is likely to have exclusively used when a babe. The *u* of the last word was sounded as in French, as also were the nasal sounds of *non* and *Nanan*, things which her mother could not have done. Inheritance of memory has been observed in the case of birds, which soon learn to avoid the telegraph-wires, while their young seem equally ready in keeping away from them. Chauncey Wright is quoted as saying of those dreams of strange places and events that often recur to one in his sleep, with the intimation of being familiar though never seen in a wakeful state, that they are inherited memories. Dr. Valin also relates of his own personal experience: "My mother was brought up and educated in a most romantic country village, which she revisited a few months before I was born. The first time I visited it I remembered vividly having been there before. In fact, I could tell at that time what next would follow in the scenery, and I argued with my relatives who were denying my former knowledge of that place; my mother having died when I was about nine months old, and I had not had any description of it from any one, or conversed with any one in regard to the village scenery." A little girl in Burlington, Vermont, with whose family Dr. Valin at one time resided, "had inherited so good a memory of an uncle, whose funeral had been attended by her mother not long before this little girl's birth, that she could give a full description of him, and knew his picture at once the first time that she ever saw it." Some of these cases may have been maternal impressions, but the first one was undoubtedly one of inherited memory.

Alum as a Water-Clarifier.—According to a paper by Professor P. P. Austin, of the New Jersey State Scientific School, extensive use has been made in late years of alum in the processes of purifying water, sewage, etc. It is not improbable, the author says, that, aside from its effect in precipitating matter mechanically by envelopment within the precipitating basic aluminic sulphate, the alum exerts a coagulative action on the albuminous substances in the water, rendering them insoluble, and thus causing their precipitation — perhaps the same or similar effect that alum produces in the tanning of leather. Alum has the great advantage that it is cheap, can be obtained everywhere, and is not highly poisonous. The larger the amount of alum added to the water the more quickly will the separation take place; the smaller the amount added, the longer will the water have to stand before a clarification will be effected. Again, large bodies of water will be precipitated by smaller amounts of alum than one would infer from experiments on a small scale, as the mechanical action of the precipitant here, in enveloping and carrying

down suspended matter, is greater in a large body of water than in a small one. It will be better, however, to err on the side of too large an amount, for even then the amount of alum added will be insufficient to impart any detrimental properties to the water. The water, after precipitation has taken place, is perfectly clear and sparkling, and has acquired neither taste nor smell. For use in the dye-house no possible objection can be made to it.

The Story of India-Ink.—India-ink is of comparatively late introduction in Europe. It was a rarity in the middle of the seventeenth century, and a record exists of a stick of it being preserved along with some "giants' teeth" — mammoth bones—as a curiosity, in the Museo Moscarda, in 1672. The Chinese, however, assign a great antiquity to its use in their country, and name, as the inventor of it, Tien-tchen, who flourished between 2697 and 2597 B. C. About two hundred and fifty years B. C., balls were made of lampblack from fir-wood, lacquer, and size. A poet of that day, singing of this precious material of his art, mentions with especial praise the ink that was made of the firs from the hill-side of Lou-Chan, in the province of Kiang-si. This province was celebrated for the fine quality of its ink, which was at one time made under the supervision of an hereditary government officer as overseer. A number of sticks of the ink were sent every year to the emperor as a tribute. There were illustrious names among the Chinese ink-makers. The most famous of them was Li-ting-Kouei, who not only made his sticks of a quality which has become proverbial, like that of the Stradivarius violins, but molded them into a variety of quaint and artistic forms, and received a special honor from the emperor. During the long history of the Chinese-ink, a great variety of processes have been employed in its manufacture, and nearly every kind of combustible has been used for the production of the lampblack. That resulting from the combustion of petroleum is said to make a more brilliant and blacker ink than that made from fir-wood. The size by which the particles of the lampblack are held together is frequently of animal origin, being made from the bones of the stag, rhinoceros, and ox, and from various kinds of fishes. The Chinese instruments of writing have been assigned supernatural guardians, whose places of precedence are settled by strict rules of etiquette. The "Prefect of the Black Perfume" is the official style of the ink-deity, and he is of higher rank than the divinities of the pencil and the paper. It is said that, a very long time ago, this divinity appeared to the Emperor Hiuan-Tsong while he was writing, and announced to him that henceforth, when a man of true learning or genius should write, the twelve deities of ink should make their appearance to testify to the reality of his powers. It is said that the twelve deities of ink have never appeared since.

Periodicity of Cyclones.—Mr. Charles Meldrum, in continuation of his observations relative to his theory of the periodicity of cyclones, which he believes to occur in cycles corresponding with the eleven-year cycle of sun-spots, has published the results of the meteorological observations which he has systematically compiled from the log-books of vessels traversing the Indian Ocean for the nine years 1876–'84. The observations averaged forty-six for every twenty-four hours included in the review. By the aid of these records nine cyclone-charts have been prepared, one for each of the years, and these, together with the twenty that had previously been prepared for the years 1856–'75, show, as far as has yet been ascertained, the tracks of the cyclones of the Indian Ocean south of the equator in each of the years 1856–'84. The tracks for the years 1848–'55 are nearly ready. With respect to the period 1876–'84, the areas of cyclones and the distances traversed have not yet been determined, but, upon the whole, the number and duration of the cyclones decreased to a minimum in 1880, and then increased till, in 1884, they were more than double what they were in 1880. From the accompanying track-charts for the eleven years, 1856, 1857, 1860, 1861, 1867, 1868, 1871, 1872, 1879, 1880, and 1884, it appears that the number and duration of the cyclones of 1856 and 1857 were much less than those of the cyclones of 1860 and 1861;

that those of 1867 and 1868 were much less than those of 1860 and 1861, on the one hand, and of 1871 and 1872 on the other; and that the number and duration of the cyclones of 1879 and 1880 were much less than those of the cyclones of 1871, 1872, and 1884; but it appears that in 1884 there was less cyclone activity than in 1861 and 1872.

Antiseptics and Disinfectants. — The Committee on Disinfectants of the American Public Health Association calls attention in its report to a distinction which is not always accurately enough observed between disinfectants—substances which destroy germs—and simple antiseptics—which prevent their development. Many of the preparations put on the market as disinfectants are in reality only antiseptics. While practically the words disinfectant, in its strict sense, and germicide, are considered to mean the same thing, so long as it is not proved that all infections are developed from germs, we must regard "disinfectant" as a word of more general significance than germicide. But, as a matter of fact, those agents which by laboratory experiments have been proved to be the most potent germicides have also been shown to be the most reliable disinfectants. While antiseptic agents may fail to fulfill the stronger purpose of disinfectants, they are known to exercise a restraining influence on the development of disease-germs, and their use during epidemics is recommended, when masses of organic material in the vicinity of human habitations can not be completely destroyed or removed, or disinfected. A substance of this kind is sulphate of iron, or copperas, which, while it does not destroy the vitality of disease-germs or the infecting power of material containing them, is a very valuable antiseptic, the low price of which makes it one of the most available agents for the arrest of putrefactive decomposition. While an antiseptic agent is not necessarily a disinfectant, all disinfectants are antiseptics; for putrefactive decomposition is due to the development of germs of the same class as that to which disease-germs belong, and the agents which destroy the latter also destroy the bacteria of putrefaction when brought in contact with them in sufficient quantity, or restrain their development when present in smaller amounts. Antiseptics are a poor substitute for cleanliness.

Wind-Carving in Maine.—Mr. George H. Stone discusses, in the "American Journal of Science," some instances of wind-action on till and bowlders which he has observed in Maine. One of the features of the surface geology of this State is the large areas of sand which were deposited by most of the rivers along the lower part of their courses during the Champlain epoch. The valley of the Androscoggin is particularly distinguished by its sand-dunes. Not rarely spots bare of vegetation can be found on hill-sides exposed to high winds, where, during dry days, the wind removes the finer parts of the till and drives the gravel back and forth just as happens in Colorado during the dry winter weather. The effects of this process are, however, usually obliterated or obscured by the frequent rains and abundant snows; but the wearing marks of the action are plainly observable in many cases, as on the top of a hill near Wayne village. At Bethel are found bowlders which exhibit on one or more of their surfaces grooves, scratches, striæ, and polishings, the origin of which was for a long time problematical; and similarly marked stones have been noticed at Gilead and in Gorham, New Hampshire, all near the Androscoggin River. Mr. Stone believes that he solved the mystery of these marks during his investigation of the glacial gravels of the region in the summer of 1885. In numerous places, at Bethel and elsewhere, he found "bowlders and even small stones which are now being sand-carved by the wind as plainly and incontestably as in Colorado. The drifting dunes of fine sand do not produce this effect to any great extent, probably because the stones are covered and uncovered too rapidly. But there are bare spots not protected by grass where coarse sand and gravel are driven back and forth by the wind, and here the carved bowlders can be seen in considerable numbers and in all stages of the process. In some cases it appeared probable that these bare places were where drifting sand had swept over the surface and the till had been partially denuded by

the wind. . . . Every feature of the Bethel bowlders under consideration is fully accounted for by the hypothesis of sand-sculpturing under the action of the wind." An accessible locality for observing this action is found about a mile from West Bethel, on the east side of the road leading to Mason.

Should Children go barefooted?—The "Lancet" gives a decided affirmative answer to the question, "May children go barefoot without injury?" It holds that, on physiological grounds, it is manifestly a sound practice to accustom children to develop the circulatory and muscular systems of the lower extremities, as those of the hand are developed, by free use and exposure. No one thinks a child ought to be protected from the weather, so far as its hands are concerned, but it is recognized that the upper extremities should be kept warm by exercise and habitual exposure. The bones and vessels need freedom for development; and if the blood-vessels of the foot and leg are fully developed, as they can be only when the foot is habitually exposed, the quantity of blood which the lower extremities can be made to receive, and if need be attract for a time, is very considerable. Children who are allowed to go barefooted enjoy almost perfect immunity from the danger of "cold" by accidental chilling of the feet, and they are altogether healthier and happier than those who go about with their feet done up. For the poorer classes of children, "it is incomparably better that they should go barefooted than wear boots that let in the wet and stockings that are nearly always damp and foul."

Development of Fleas.—Mr. George Harkus has succeeded in observing the whole process of the development of the flea from the laying of the egg up. He undertook to begin his experiment with two egg-laden females in a box, but the only result was a fierce battle that compelled separation of the two at once. Each individual laid a batch of from three to twenty-four eggs—the average was about a dozen—white and oval. Each end of the ova appeared through the glass surrounded by a spiral whorl of oval punctures, eighty at one end and forty at the other. The eggs were so nearly transparent that the whole process of development could be easily watched, and the exhibition, to judge from the warm terms in which it is described, must have been extremely interesting. The larvæ resembled elongated little worms, were destitute of feet, and kept up the usual wriggling motion of their kind. They absolutely refused to be fed, and usually died in a few days, so that very few chrysalides were obtained. Perhaps, if they had been given their natural way of feeding, whatever that may be, the success might have been better. Any exposure to cold or damp was immediately fatal. The larvæ, as the pupa stage is approached, assume a red hue, and, about eight days from hatching, spin a cocoon like a fluffy speck of white cotton. The threads are closely woven and of extreme tenuity, and, when attached to a textile material of similar color, must be very difficult of detection. A cocoon was opened after the inmate had divested itself of the pupa-case, but still remained enveloped in a filmy transparent integument. This pellicle covered the insect completely, following each leg and antenna continuously. "About four weeks is required to metamorphose the speck of vitalized matter contained in the minute ovum of *Pulex irritans* into a suctorial tormentor."

Science in Japan.—A wise step was taken when the University of Tokio and the Engineering College were merged into one organization. This institution, now called the Imperial University of Japan, comprises five colleges, representing the departments of law, medicine, engineering, literature, and science. Each of these colleges has its special director. The College of Science is showing great activity in biological work. Mr. Ishikawa, who recently graduated, is now in Freiburg, studying under Weissmann. Mr. Matsumura, the assistant professor of botany, is in Wurzburg, under Sachs. A marine laboratory is to be built at Misaki, Sagami. Mr. Tsuboi, a student who graduates this year, is to study anthropology as a specialty. A new journal is to be established by the College of Science, from which we infer that the memoirs of the University of Tokio will be discontinued. The first num-

ber of the new journal will contain a memoir by Professor Sasaki on the development of the maggot parasite in the silk-worm. The government awarded Professor Sasaki a gift last year in recognition of his admirable discoveries concerning the diseases of silk-worms. The Tokio Anthropological Society, although recently organized, is doing excellent work. It has already issued five numbers of its journal, each one illustrated by lithographic plates. We wish, for the benefit of foreign readers, it would give a brief synopsis in English of the contents of each number. Mr. Iijima, who studied with Leuckart in Leipsic, and took the gold medal over all the German students for the best thesis, is again in his native land and working in the laboratory of the college. E. S. M.

The Lengthening of Human Life.—The "Lancet," apparently accepting the general opinion that the maximum age attainable by man has risen somewhat during the present century, observes that the line of seventy years is now very frequently passed, that many reach fourscore "without excessive labor and sorrow," and that "we have among us nonagenarians who carry on with still respectable proficiency the activities of their prime. Such effective longevity is a bright spot in the history of our advancing civilization. Its comparative frequency and its association with different physical types suggest a certain generality in its origin, and encourage the hope that it may be, in some measure at least, dependent on personal conduct." After middle age, however, not personal conduct, but inherited vital force, is a potential factor, although it is not an exclusive one. Disposition may have great influence upon vitality; "and there can be no doubt," says the "Lancet," "in our opinion, that there is much room for exercise of private judgment and energy in seeking the prolongation of one's own life." It is not to be believed "that man is unable so to adjust his circumstances to his needs as to continue to live after a certain mean period. The weaker will sometimes prove himself the more tenacious of life by observing rational methods of living of which the more robust is careless. Moderation has probably more to do with success in this respect than anything else. To eat sufficiently, and drink stimulants sparingly, to alternate work with adequate rest, and to meet worries heartily, will afford every one the best chance of arriving at a ripe old age."

Premonitions of Inebriety.—Dr. T. D. Crothers, of Walnut Lodge, Hartford, Connecticut, having studied "the incipient stages in inebriety," endeavors to show that the oncoming of the disease, as he regards it, may be foreseen, and that preventives and curative measures applied at that time give more promise of certain results than at any other period. Sometimes premonitions of inebriety reveal themselves in the dispositions of the subject before any spirits have been used by him; when they may be marked by dietetic delusions and other symptoms of nerve and brain irritability, which seem to depend on heredity or some obscure injury to the nerve and brain centers. He believes that the recognition and study of this stage opens up a field of prevention and cure that will attract great attention at an early day.

Signal Stations at Sea.—Mr. F. A. Cloudman, of Rondout, New York, has projected a plan for the establishment of ocean-signals, light-ships, and life-saving stations at sea. His system embraces a strongly constructed cylindrical vessel, with a convex upper deck, moored at such a depth of submergence as will give it the greatest attainable stability, by means of cables and anchors fixed in the bottom of the ocean. From the top of this structure arises a skeleton framework, to sustain a brilliant electric arc-light, with Fresnel lenses, a powerful steam-siren, and ventilating, smoke, and steam pipes. The interior of the vessel is to be divided into several decks or holds, to be used as cabins, offices, operating and apparatus rooms, etc. An ocean-cable is to be run from shore to shore, looping in at each of the stations. For deep-sea service, the stations should be placed at maximum distances of five hundred miles from one another. For coast service, they should be placed at or near dangerous shoals, reefs, etc., and connected by telegraph cable with the mainland.

NOTES.

The American Association, at its recent Buffalo meeting, chose Professor S. P. Langley as its president for the year. The vice-presidents or presidents of sections elected are: Mathematics and Astronomy, William Ferrell; Physics, William A. Anthony; Chemistry, Albert B. Prescott; Mechanical Science and Engineering, Eckley B. Coxe; Geology and Geography, G. K. Gilbert; Biology, W. G. Farlow; Anthropology, D. G. Brinton; Economic Science and Statistics, Henry E. Alford. Permanent secretary, F. W. Putnam; general secretary, W. H. Pettee; assistant general secretary, J. C. Arthur; treasurer, William Lilly. The place for the next meeting was not decided upon.

The "Botanical Gazette" says: "'The Popular Science Monthly' for June contains a portrait and biographical sketch of the late Dr. George Engelmann. The author is anonymous, but can hardly have been a botanist, or he would not be so ignorant of the true authorship of the classic 'Plantæ Fendlerianæ' as to say, 'In 1849 Dr. Engelmann published in the "Memoranda [*sic*] of the American Academy of Arts and Sciences" the "Plantæ Fendlerianæ."' He infelicitously adds, regarding Fendler: 'Fendler and he [Engelmann] had become acquainted on a governmental expedition to the Rocky Mountains, to which the former was attached as engineer. . . . He traveled in the Rocky Mountains, California, Mexico, Central America, and Brazil.' Fendler did not become acquainted with Engelmann in this way; he was never attached officially to any governmental expedition; he was not an engineer; and he traveled neither in the Rocky Mountains, nor California, nor Mexico, nor Central America, nor Brazil!"

Our sketch of Dr. Engelmann was prepared from documents furnished us by his friends in St. Louis. The statements to which the "Gazette" objects are given precisely as they appeared in one of the papers. As the "Gazette" has recently published Fendler's autobiography, it is probably in a position to be better informed, respecting the events of his life, than is the biographer of another man who only had occasion to refer to them incidentally. We are glad to be set right on the facts.

Professor L. E. Hicks, in one of the papers which he read at the American Association on the geology of Nebraska, spoke of the strong artesian flow of water contained in all the borings of the eastern part of the State. This is because the region is a vast synclinal trough or basin, of which the western rim is three thousand feet higher than the eastern.

Professor Asa Gray sent two communications of a technical character to the American Association, and with them a letter to the Botanical Club, respecting his nomenclature of violets. He makes out thirty-three wild North American species of these plants, of which only eight are represented in the Old World. He acknowledges himself to be in doubt whether our pansy violet is indigenous to this country.

Mr. Joseph Jastrow read a paper before the American Association on centenarianism, in which he made an elaborate calculation of the proportion of cases in which claims to this distinction should be eliminated for want of trustworthy evidence, or as based on exaggeration. Removing these, he concluded that there were about fifty centenarians in the United States. Some of his conclusions were disputed; but he is said to have, in the discussions that followed, shown himself to be well fortified.

The statistical reports of the American Association show that it has doubled its membership within the last twenty years. Two hundred and fifty-two papers were read at the recent Buffalo meeting, against one hundred and seventy in 1876, and sixty-seven in 1866.

"Theism" is the somewhat awkward and confusing name given to a class of diseases that arise from the wrong use of tea. The predominance of nervous symptoms is a characteristic of the condition; and it may be observed in a general excitation of the nervous function, or in special weakness of the brain. Perversion of the sense of hearing is a not uncommon form of the symptoms. The weakness that often overtakes women may sometimes be traced to excessive indulgence in their favorite drink. Taken in strict moderation, and prepared with proper care, tea is a valuable stimulant; but there is hardly a morbid symptom that it is not capable, when used in excess, of producing.

The American Association designated Dr. Pohlman, of Buffalo, who had served as its local secretary, as its representative at the meeting of German Naturalists and Physicians. This will be its first formal representation before that body.

According to M. Mantegazza, 64 per cent of the Italians have chestnut, 22 per cent black, 11 per cent blue, and 3 per cent gray, eyes; 71 per cent of them have chestnut, 26 per cent black, and 3 per cent blonde hair. More than three fourths of the people have abundant hair. Southern Italy excels Northern Italy in this respect. In Tuscany the poor heads of hair preponderate (58 against 42 per cent), and baldness is most common there. The color of the beards

does not always correspond with that of the locks. Generally, of ten thousand young men examined for military service, twenty were rejected for premature baldness, and fifty-two for diseases of the scalp. A few cases of red hair are found, and in one commune this color is predominant. The origin of this colored hair is a subject of discussion. Some think it has come down from an almost extinct race; others that it is a mere physiological accident, from which no conclusion can be drawn.

The English National Fish Culture Association reports that its last year's growth of newly hatched salmon was six and a half inches, and of white-fish five inches.

Mr. Blanford, meteorological reporter to the Government of India, is testing from year to year a theory of a connection between the Himalayan snow-fall and the monsoon, to the effect that the later and heavier the snow-fall in winter and spring, the later and feebler would be the following monsoon. The forecasts according to his theory were fairly accurate last year. This year they appear favorable to a prompt monsoon and abundance of rain.

A Swedish naturalist remarks upon the frequency with which names derived from natural history are adopted by the nobility of his country. Lion, eagle, tiger, wolf, and bear, and even mythical animals like the griffin and the dragon, have furnished several families with parts of their names. Most of the domestic animals are also represented, and plants, such as the lily, rose, laurel, cedar, oak, and lime, are still more fully represented. Numerous stars form the prefix of names, but in no case the sun or moon. The word *stjerna*, star, is used both at the beginning and at the end of names; but the *stjerna* in Oxenstjerna does not represent this word, but the German *Stirn*, forehead.

M. Blanchard conceives that the recent seismic catastrophe in New Zealand lends probability to his theory that that island is one of the remnants of a formerly existing Australian continent that has been submerged. Evidence was wanted of the liability, present or past, of the regions to shocks severe enough to suggest that former stronger shocks might have produced such phenomena of submergence as he predicates. The late shock was one of the kind.

MM. Cailletet and Mathias have reported to the French Academy of Sciences concerning their researches on the density of the liquefied gases—in the cases of protoxide of nitrogen, ethylene, and carbonic acid, that at the critical point the density of the liquid gas is equal to that of its vapor.

The number of births in France per ten thousand inhabitants has diminished more than one third in a century. It was 380 in 1771–'80, 289 in 1831–'40, and only 241 in 1871–'80.

Mr. Alfred Bennett has given an interesting account of the egg-laying and hatching habits of the emu. The hen-bird lays her brood of twenty eggs or more, at intervals of two days, during about six weeks in October and November. Before the process is completed, the cock-bird begins to sit. The eggs laid subsequently are deposited by the hen by the side of her mate, who puts out his foot and draws them under him. As soon as the eggs begin to hatch it is necessary to isolate the hen, because she fights furiously with her mate and seems disposed to kill the chicks if she could get at them. The whole of the tending of the young is performed by the male bird.

The first case of the admission of a woman to the French Academy of Sciences occurred on the 28th of June, when Sophie Kowlewska, Professor of Mathematics at the University of Stockholm, and daughter of the eminent paleontologist, was received as a member. Admiral Jurien de la Gravière, President of the Academy, made her a graceful address of welcome, and she took her seat between General Fave and M. Chevreul.

Miclucho Maclay, the explorer of New Guinea and the neighboring islands, has brought with him to Odessa, Russia, a large collection of objects illustrating the qualities of scientific interest in the countries in which he has traveled.

OBITUARY NOTES.

Mr. Gerrard Kinahan, son of the Irish geologist, who had connected himself with an African trading company, was killed by a poisoned arrow in a fight with the native tribes at Anyappa, May 23d. His training as a chemist and geologist at scientific schools in Dublin and London had thoroughly qualified him for scientific research, and there is no doubt that had he lived he would have added much of value to our knowledge of Africa.

The death is announced of Mr. George Busk, F. R. S., a well-known English surgeon and naturalist, in the seventy-eighth year of his age.

Dr. R. J. Mann, who was for three years President of the English Meteorological Society, has recently died. He was a popular and prolific writer, and gave much attention to the subject of the protection of buildings from lightning. He was for several years head of the education department and medical officer in the colony of Natal.

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